

HIGH DEFINITION TELEVISION

HEARING BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

MARCH 22, 1989

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HIGH DEFINITION TELEVISION

WEDNESDAY, MARCH 22, 1989

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The committee met at 9:40 a.m. in Room 2318, Rayburn House Office Building; Honorable Robert A. Roe, chairman, presiding.

Present: Representatives Roe, Walker, Brown, Scheuer, Boehlert, Walgren, Glickman, Packard, Hall, Fawell, Valentine, Smith [Texas], Torricelli, Morella, Bruce, Rohrabacher, Campbell, McMillen, Skaggs, Costello, Johnston, and Tanner.

The CHAIRMAN. The hearing will come to order. To make it comfortable for the folks who are here, first of all I want all people who are not members of the press to clear that press table. That belongs to the press. If you don't have a chair, some people have coats on chairs, take them off if you will, please, and let someone sit down.

As for those people who do not have seats, there are a couple up in here.

[Pause.]

The rest of you, I am sorry, you will just have to sit on the floor, or relax and stand, or change with somebody else. It's all right. I'm not going to be offended if you decide to sit on the floor. It's okay.

All right. I want to welcome you all for this hearing this morning, which we consider to be an extremely important hearing. The issue before us today, high definition television systems, is one of the paramount scientific research, technological, and economic items facing the United States. Almost daily, the press and national media feature a news hearing regarding high definition television (HDTV).

HDTV, as you know, in a digital form, presents a much sharper and clearer image than existing TV sets, images that are as fine as those of 35 millimeter film. But HDTV means more than just better pictures or larger displays or even a new generation of TVs in our living rooms, and it means more than the new jobs putting together cabinets and picture tubes. HDTV means new markets for the components of advanced television, such as semiconductors, fiber optics, and flat screen displays. These markets will bring with them new wealth for the United States and directly impact our national economy, international trade, competitiveness, and national security.

In the 1970s, the United States lost to the Japanese and others its competitive edge in the television industry. There is today only one wholly American owned company in the television industry.

We also lost the VCR market and have little or no entries in the manufacture of Camcorders. If we stand still on the advanced television issue, then we will also lose that industry to our foreign competitors.

Our competitors abroad have not been standing still on advanced television either. The Japanese have been working on analog HDTV for two decades now and are getting ready for direct broadcast satellite transmission for advanced television by 1990. The European community demonstrated a viable HDTV system in September 1988, after an investment of \$175 million, and recently formed a government/industry corporation to market their version of HDTV. At a meeting in Moscow in January, a group of 25 broadcast and motion picture companies endorsed a drive to achieve a single worldwide HDTV production standard, and the testing of the system will be held in Moscow, providing the Soviets with HDTV technology.

We can strike out on a new initiative today to revitalize the consumer electronics industry by providing initiatives for research and development of digital HDTV components. This will enable the United States to regain our technological leadership, expand our research and development base, and pursue this dual use technology with its associated applications in defense. We can encourage our entrepreneurs to fully participate in the creation of new wealth domestically and successfully compete internationally; or, we can become a nation of assemblers of HDTV components developed by foreign entities. This will result in an erosion of our national economy, reduced jobs for scientists and engineers, an increase of our trade deficit and result in a dire threat to our economic and national security.

Some sides of the debate may claim that more of this will occur, that HDTV may prove to be the Nehru jacket of the consumer electronics industry. Some say that the market is large enough for everyone to have a share. Is the risk small enough to stand by and do nothing while the Japanese and the Europeans continue on their paths of HDTV development?

We are here today to determine what role the government should play in industry-led initiatives in pursuing digital HDTV technology, to discover what barriers may exist to the commercial success of the American HDTV industry, and to explore what type of developments U.S. participants should pursue to ensure competitiveness and technological leadership.

As a minimum, we have the opportunity to provide funding in support of digital HDTV joint ventures through the Advanced Technology Program at the National Institute of Standards and Technology. This program was established by this committee's section of the Omnibus Trade and Competitiveness Act of 1988 for the "purpose of assisting U.S. business...to commercialize significant new...technologies rapidly...and focus on improving the competitive position of the United States and its business."

Today our witnesses come from government, industry, and academia. We trust they can help us to clarify many of the issues that we face in pursuing HDTV. Hopefully, their experience, expertise and vision will help us to formulate a plan and the proper plan of

action. HDTV has been studied, discussed, and debated long enough; now it is time for action.

That closes my statement. In view of the fact that the Ranking Minority Member cannot be here this morning, Mr. Walker, I would ask unanimous consent that his statement be included at this point in the record. If there is no objection, so ordered.

[The prepared statement of Hon. Robert S. Walker follows.]

HONORABLE ROBERT S. WALKER (R-PA)
OPENING STATEMENT
HEARING ON ADVANCED TELEVISION SYSTEMS
REGAINING THE COMPETITIVE EDGE
MARCH 22, 1989

MR. CHAIRMAN, I WANT TO COMMEND YOU FOR HOLDING THIS HEARING AT THE FULL COMMITTEE LEVEL. AN AMERICAN-BASED HIGH-DEFINITION TELEVISION SYSTEM IS THAT IMPORTANT TO THE FUTURE WELL-BEING OF OUR NATION. AS WE WILL HEAR, AMERICAN LEADERSHIP IN THIS NEW EMERGING TECHNOLOGY HOLDS THE POTENTIAL FOR VERY SIGNIFICANT ECONOMIC GROWTH, WEALTH AND JOBS (IN FACT, 175,000 JOBS BY THE TURN OF THE CENTURY IS CONSERVATIVE). AND THESE WOULD BE PERMANENT, REAL JOBS BASED FIRMLY IN THE PRIVATE SECTOR, QUITE DIFFERENT FROM SO MANY OF THE SHORT-TERM, MAKE WORK GOVERNMENT PROGRAMS OF THE PAST, AND STILL, UNFORTUNATELY, THE PRESENT. CONTRAST THE 175,000 HDTV JOB ESTIMATE FROM THE U.S. DEPARTMENT OF COMMERCE I JUST MENTIONED WITH THE ANEMIC 2,140 CONSTRUCTION JOBS THE COMMERCE DEPARTMENT'S ECONOMIC DEVELOPMENT ADMINISTRATION ESTIMATES IT DIRECTLY CREATED IN 1988. THOSE 2,140 JOBS WERE THE RESULT OF A \$120 MILLION TAXPAYER INVESTMENT. THAT'S OVER \$55,000 PER JOB AND THEY'RE GONE WHEN THE FEDERAL MONEY IS GONE.

TODAY, CLEARLY THE BEST ECONOMIC DEVELOPMENT IS TECHNOLOGICAL DEVELOPMENT. THIS COMMITTEE KNOWS THAT. THAT'S WHY WE ARE SO INTERESTED IN HDTV AND OTHER CUTTING-EDGE TECHNOLOGIES. THAT'S WHY WE WANT TO FIND OUT EXACTLY WHERE U.S. INDUSTRY IS, WHAT IT CAN DO, AND HOW GOVERNMENT CAN HELP. FIRST AND FOREMOST IS THE QUESTION OF WHAT BARRIERS EXIST TO U.S. INDUSTRY COMMERCIALLY DEVELOPING HDTV. WHETHER THOSE DISINCENTIVES ARE REGULATORY, ANTITRUST OR TAX, WE SHOULD LOOK AT HOW THEY CAN BE OVERCOME. AFTER THAT, INDUSTRY MUST DEMONSTRATE WHAT ADDITIONAL NEEDS, IF ANY, IT HAS. IT CAN DO

THIS BY PUTTING FORWARD A BUSINESS PLAN AS SOON AS POSSIBLE THAT IS INDUSTRY LED.

WITH THIS APPROACH IN MIND, I HAVE JOINED AS A SPONSOR OF H.R. 1267, MR. RITTER'S HIGH DEFINITION TELEVISION COMPETITIVENESS ACT OF 1989. IT INCLUDES A COMPREHENSIVE SET OF OPTIONS BY WHICH THE GOVERNMENT MIGHT ASSIST THE COMMERCIALIZATION OF THIS AND OTHER WORLD-CHANGING TECHNOLOGIES. IT SERVES AS A STARTING POINT, A SPRINGBOARD IF YOU WILL, AS WE BEGIN CONSIDERATION OF HOW TO BEST SPEED THIS IMPORTANT NEW CONSUMER ELECTRONIC DEVELOPMENT TO MARKET. I AM NOT WEDDED TO ANY ONE OF THESE PARTICULAR OPTIONS, BUT DISMISS NONE AT THIS POINT EITHER. HOPEFULLY, THIS HEARING WILL HELP CLARIFY THE DYNAMICS OF THIS INTERNATIONAL TECHNOLOGICAL CONTEST AND POINT US IN THE RIGHT DIRECTION AS TO THE MOST APPROPRIATE ROLE FOR THE U.S. GOVERNMENT.

I LOOK FORWARD TO HEARING FROM OUR WITNESSES. WELCOME TO OUR GOVERNMENT REPRESENTATIVES - ASSISTANT COMMERCE SECRETARY SIKES, WHO WILL PRESENT THE FINDINGS AND RECOMMENDATIONS IN HIS AGENCIES' JUST RELEASED HDTV REPORT, AND DARPA DEPUTY DIRECTOR CRAIG FIELDS, WHO CAN PROVIDE US WITH SOME INSIGHT INTO THE EXACT SCOPE AND GOALS OF THE DEFENSE DEPARTMENT'S PLANNED FINANCIAL ASSISTANCE FOR THE DEVELOPMENT OF HIGH RESOLUTION DISPLAY TECHNOLOGY.

I AM ESPECIALLY ANXIOUS, HOWEVER, FOR THE INPUT FROM THE TWO PRIVATE SECTOR PANELS. HOPEFULLY, THEY CAN PAINT A MUCH CLEARER PICTURE OF JUST WHERE THINGS STAND AND HOW THE U.S. CAN GET INTO THE GAME. A KEY QUESTION SEEMS TO BE WHETHER HDTV IS REALLY A TECHNOLOGICAL PROBLEM, OR PERHAPS, MORESO, A MANUFACTURING ONE. HOW MUCH OF IT IS A MARKETING ISSUE OR

SOME MIX OF ALL THESE? ONE PARTICULARLY QUALIFIED TO HELP ANSWER THAT IS MR. HAROLD KRALL, PRESIDENT OF CARDINAL TECHNOLOGIES OF LANCASTER, PENNSYLVANIA, IN MY DISTRICT. WE'RE VERY LUCKY AND APPRECIATIVE TO HAVE HAROLD JOIN US TODAY AS A MEMBER OF THE THIRD PANEL. CARDINAL IS A LEADER IN ELECTRONICS PRODUCT DEVELOPMENT HAVING BEEN INDEPENDENTLY ESTABLISHED AS A SPIN-OFF OF THE RCA-GE MERGER. HAROLD IS A WIDELY RECOGNIZED EXPERT IN THIS AREA AND I WARMLY WELCOME HIM THIS MORNING. THANK YOU, MR. CHAIRMAN.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from Pennsylvania who is now holding down the fort, you might say, who has really been a great leader in this field, and I am highly impressed with the effort and energy he has put forth over the last years in this very important area. The Chair recognizes the gentleman, Mr. Ritter from Pennsylvania.

Mr. RITTER. I thank the gentleman, and I want to thank him for his leadership in calling a full committee hearing recognizing the importance of the subject. I also wish to say that I am sitting on pins and needles. I just received a note that I am to go to the Capitol Hill Club and vote on what is probably one of the most significant leadership votes for the Republican party, certainly since I have been in the Congress, and all my Republican colleagues are there, and I will be there in moments.

Mr. Chairman, high definition television is a technology whose time has come for America. As I have mentioned before, television and the automobile are the two most important inventions of the 20th century. Just as the automobile gave mobility to people, television gives mobility to ideas. Currently, there is only one American-owned color television producer still in operation, represented here by Zenith Chairman and CEO Jerry Pearlman. Would we have done this to the American automobile industry? I think not. The time has come to address the longstanding disincentives and lack of incentives which have hastened the flight of American industry out of the consumer electronics business.

Mr. Chairman, both our colleague George Brown and I have tried to address the HDTV problem. On March 2, I and Mel Levine, the co-chair of the Congressional HDTV Task Force, along with myself, introduced the High Definition Television Competitiveness Act of 1989. There are currently 16 other bipartisan cosponsors, including Mr. Brown, Mr. Torricelli, Mr. Hayes, Mr. Smith, Mr. Boehlert and Mr. Walker of this committee. Our bill is a comprehensive approach to try to create an American strategy for an American HDTV. As was mentioned by my colleague the chairman, just yesterday, Mr. Brown introduced the High Definition Television Research and Development Act of 1989, and I am a proud original cosponsor of this legislation, which I am sure will be discussed in the hearing today.

The title of this hearing, "Advanced Television Systems- Regaining the Competitive Edge," sums up what we need to do. Regaining the competitive edge will not be easy. It will be a struggle. The Japanese started working on this in a coordinated fashion some 20 years ago. The Europeans got going in this battle less than eight years ago and have done well, have almost caught up. With our expertise in computers, microprocessors, solid state sciences and digital technology, I can see an eventual neck and neck race if we give the American creative enterprise room to run, if we create the appropriate environment. A lot was, and is, at stake. But even though we started late, I believe we can survive, catch up, and eventually win. Both the Ritter/Levine bill and the Brown bill will give American industry a much needed jump start.

But I still emphasize that the Science Committee action cannot, in and of itself, solve this problem. A comprehensive strategy is essential and, hopefully, Mr. Sikes can speak on behalf of the Admin-

istration, who I might say is energetically pursuing a comprehensive strategy for HDTV.

I look forward to hearing what our witnesses have to say about the future of American competitiveness in HDTV and about the bills currently before us. Television, the ability to transmit a visual image of action from one place to another—and all that the future of TV holds as this technology is improved from generation to generation—is too important for this nation to watch from a collective armchair. To miss out on creating HDTV today and on shaping what it will become tomorrow is to miss out on the 21st century.

Thank you very much, Mr. Chairman, and I will excuse myself. I will be back after the vote.

The CHAIRMAN. We thank the gentleman from Pennsylvania.

The Chair recognizes the distinguished Ranking Member from California, Mr. Brown.

Mr. BROWN. Mr. Chairman, I ask unanimous consent to insert a statement in the record.

The CHAIRMAN. Unanimous consent is made. Any objection? All those in favor signify by saying aye. Contrary? Carried.

[The prepared statement of Hon. George E. Brown, Jr. follows.]

THE HONORABLE GEORGE E. BROWN, JR.
OPENING STATEMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING ON
HIGH DEFINITION TELEVISION

March 22, 1989

Mr. Chairman, America may have already lost the international race to develop high definition television systems (HDTV). Japan, through its Ministry of International Trade and Industry, has already spent more than \$500 million on HDTV. The total Japanese investment is between \$700 million and \$1 billion. The Europeans have created the "Eureka" consortium and have financed its HDTV technology development to the tune of \$200 million. Even the government of Korea is outspending the United States government on HDTV by two to one--Korea will spend \$60 million on HDTV.

I call my colleagues' attention to an article in yesterday's New York Times which describes Japan's intention to begin an HDTV demonstration program next month. This is yet another example of how far ahead the Japanese are in HDTV commercialization. American HDTV efforts are non-existent by comparison. How can we pretend that America is a competitive economy if we sit idly by while other nations aggressively conduct research on HDTV? The Japanese are able to bring the fruits of that research to the market long before we get seriously involved. The potential global HDTV market is estimated to be about \$40 billion by 2010, and other nations intend to have a substantial piece of that market.

The only government driven effort in the U.S. on HDTV is a \$30 million program within the Defense Advanced Research Projects Agency (DARPA). All other talk about HDTV by the Administration and Congress has been just that--TALK.

The Members of this Committee have an opportunity to give the U.S. consumer electronics industry a hand up in HDTV technology. Yesterday, along with four of my colleagues on this Committee, I introduced a measure which will go far to bolster the U.S. prospects for competing in HDTV. "The High Definition Television Research and Development Act" would direct the National Institute of Standards and Technology within the Department of Commerce to initiate a cooperative public-private research and development program on HDTV. Such public-private joint ventures are permitted under the Advanced Technology Program, created under Section 5131 of the Omnibus Trade and Competitiveness Act (P.L. 100-418).

When the legislation for the Advanced Technology Program was written, HDTV as a competitiveness issue was hardly worth mentioning. Now that HDTV is a full-blown challenge for the U.S. electronics industry, the value of the Advanced Technology Program is apparent. I only regret that I must introduce legislation to force the Administration to take action which it should have been doing all along. I hope that before too long the Administration will understand the value and necessity of the Advanced Technology Program and act without Congress forcing its hand.

The High Definition Television Research and Development Act would provide \$100 million a year for five years in matching funds to create one or more consortia for HDTV research and development. This level and scope of commitment is essential for the U.S. to get back on track in the HDTV competition. According to the American Electronics Association, 17 companies have already agreed to consider forming a partnership to develop HDTV technology.

Mr. Chairman, we would be fooling ourselves if we thought that America can compete in the HDTV field without direct and substantial federal cooperation and support. Fundamentally, I believe in the free market ideals on which the U.S. economy was founded and has thrived for more than two centuries. However, I also understand that in order to compete, you have to play by the same rules as everyone else. The rules of the HDTV game include strong government support and private sector cooperation. If we are not willing to play by the rules, we will never get in the game.

Mr. Chairman, I look forward to the hearings today. I am particularly interested in testimony from the Administration witnesses on how American industry can compete with the Japanese and Europeans in HDTV technologies given the current level of U.S. government involvement.

Thank you, Mr. Chairman.

The CHAIRMAN. Is there anyone else who wants to make an opening statement at this point?

The gentleman from Pennsylvania, Mr. Walgren.

Mr. WALGREN. Thank you, Mr. Chairman. And perhaps I could also submit a statement for the record.

The CHAIRMAN. Is the gentleman asking unanimous consent?

Mr. WALGREN. I would ask unanimous consent to submit one statement for the record.

The CHAIRMAN. No objection. So ordered.

[The prepared statement of Hon. Doug Walgren follows.]

OPENING STATEMENT OF THE
HONORABLE DOUG WALGREN (D-PA)
ON
HIGH DEFINITION TELEVISION

March 22, 1989

THIS MORNING'S HEARING ON "HIGH DEFINITION TELEVISION: REGAINING THE COMPETITIVE EDGE" COMES AT A MOST IMPORTANT TIME. IN THE PAST SEVERAL MONTHS, AN INCREASING NUMBER OF INDIVIDUALS HAVE COME TO THE CONCLUSION THAT WE HAVE REACHED A CROSSROADS IN CONSUMER ELECTRONICS IN THIS COUNTRY AND THAT THE FUTURE OF THE AMERICAN ELECTRONICS INDUSTRY WILL BE GREATLY AFFECTED BY THE ACTIONS THE GOVERNMENT TAKES OR DOES NOT TAKE IN THE NEXT FEW MONTHS.

ALL TOO OFTEN IN RECENT YEARS A FAMILIAR PATTERN HAS APPEARED: AMERICAN SCIENCE AND TECHNOLOGY PERFORMS THE RESEARCH AND INVENTS THE MACHINE, AND THEN FOREIGN COMPANIES CAPTURE THE MARKET. THIS PATTERN CAN BE SEEN IN

TELEVISION AND WITH THE VIDEO CASSETTE RECORDER. IF THE AMERICAN ELECTRONICS INDUSTRY DOES NOT ACT SOON, ADVANCED TELEVISION SYSTEMS WILL BE ADDED TO THAT LIST, DESPITE THE MANY BRILLIANT IDEAS WHICH HAVE APPEARED IN RECENT MONTHS. I FOR ONE WOULD LIKE TO BUCK THAT TREND AND LAY THE GROUNDWORK FOR A TELEVISION INDUSTRY OF THE FUTURE WHERE THE UNITED STATES IS A HEALTHY, PROSPEROUS PLAYER WITH A POSITIVE BALANCE OF TRADE.

AT MY SUBCOMMITTEE'S HEARING ON THIS SUBJECT A YEAR AGO, WITNESSES ASKED FOR SOME TYPE OF GOVERNMENT LEADERSHIP AND ENCOURAGEMENT FOR PRIVATE INDUSTRIES' EFFORTS IN THE AREA OF ADVANCED TELEVISION SYSTEMS. THEIR TESTIMONY INDICATED A WILLINGNESS TO WORK WITH GOVERNMENT, TO PRODUCE A JOINT EFFORT THAT WOULD BEST CAPTURE THE BEST PRODUCTS OF THE LEADING PLAYERS IN THIS FIELD. IN TURN, WE ASKED PRIVATE INDUSTRY TO PUT TOGETHER A PLAN FOR GOVERNMENT-PRIVATE INDUSTRY INVOLVEMENT IN ADVANCED TELEVISION. I NOTE IN THIS REGARD THAT IN JANUARY, THE AMERICAN ELECTRONICS ASSOCIATION FORMED AN ADVANCED

TELEVISION SYSTEMS WORKING GROUP, AND HAS HIRED A PROFESSIONAL CONSULTING FIRM TO PRESENT THEIR PLANS FOR ADVANCED TELEVISION SYSTEMS. AT LAST COUNT, OVER THIRTY-THREE COMPANIES BELONGING TO THE AEA HAD JOINED THIS GROUP.

THIS IS NOT THE TIME TO STAND STILL IN THIS NEW EMERGING TECHNOLOGY. AS HAS BEEN NOTED, OUR FOREIGN COMPETITORS ARE MOVING AHEAD QUICKLY ON THIS ISSUE. THE JAPANESE, THE EUROPEANS, AND THE SOVIETS ARE PROGRESSING AT VARIOUS STAGES ON THEIR HDTV SYSTEMS. IF WE DO NOT ACT SOON, WE WILL FORFEIT THIS NEW MARKET TO OVERSEAS COMPETITION.

LAST YEAR, THIS COMMITTEE WROTE A VERY IMPORTANT PORTION OF THE OMNIBUS TRADE AND COMPETITIVENESS ACT. SECTION 5131 OF THAT ACT CREATED AN ADVANCED TECHNOLOGY PROGRAM AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. TODAY WE WILL TAKE A LONG HARD LOOK AT THE APPLICABILITY OF THAT SECTION TO HIGH DEFINITION TELEVISION. IT IS MY SENSE THAT THERE IS VERY STRONG INTEREST IN THIS CONGRESS IN

SUPPORTING COOPERATIVE RESEARCH AND DEVELOPMENT THAT WILL LEAD TO AMERICAN ADVANCED TELEVISION SYSTEMS. WE CLEARLY HAVE THE TALENT AND IDEAS IN THIS COUNTRY. OUR COMPUTER INDUSTRY IS THE STRONGEST IN THE WORLD AND IN MANY WAYS THE TELEVISION OF THE FUTURE WILL MORE CLOSELY RESEMBLE TODAY'S COMPUTER THAN IT DOES TODAY'S TELEVISION. WHAT REMAINS TO BE SEEN IS WHETHER WE STILL HAVE THE FOLLOW-THROUGH AND THE ABILITY TO LOOK TO THE LONG TERM - BEST INTERESTS OF OUR COUNTRY.

WE ON THIS COMMITTEE ARE WILLING TO EXPLORE VERY SERIOUSLY THE TYPE OF INDUSTRY-GOVERNMENT COOPERATION THAT IS REQUIRED TO PROPEL THE UNITED STATES BACK AMONG THE LEADERS IN CONSUMER ELECTRONICS, BUT WE CANNOT DO IT BY OURSELVES. THEREFORE, I FOR ONE, WILL BE LISTENING VERY CAREFULLY TODAY FOR PRIVATE SECTOR VIEWS ON WHAT IT WILL TAKE TO ACCOMPLISH THESE GOALS AND ON WHAT THE APPROPRIATE FEDERAL ROLE IN THIS CRUCIAL ENTERPRISE MIGHT BE.

Mr. WALGREN. But I would, Mr. Chairman, if I might, to express a few reservations about where we are and express what many of us feel is the importance of these hearings in enabling us to talk together about where we have to go as a country if we are not to lose out on the tremendous potential that high definition television and all the science that lies behind it holds for the future of our country and our economy.

This hearing is entitled "Regaining the Competitive Edge." One view of recent economic history is that we may not be struggling to regain the competitive edge. We may be in the battle of our lives to achieve a competitive edge, in many senses for the first time.

In one view, the dominance of America in science and technology may be more myth than fact, at least in a concrete economic sense. It is true we are the scientific leaders in research and there is no question about that. But when you look at what the financial and economic strength of America has been, it has not necessarily been in applying modern science and technology.

The wealth of this country in many ways in the 1950s was based on the fact that we were the world's leading exporter of oil, a basic natural resource that was not a manufactured product. We were the world's leading exporter of agricultural products, essentially not manufactured products.

We were the world's leading exporter and producer of manufactured goods but largely goods that were not the product of modern science but were the product of the industrial revolution and World War II and the dominance that America had in a world that was devastated.

So instead of regaining, we may be trying to gain the high ground for the first time in an area that is critically important for the future of our economic viability as a nation. Clearly, America is missing something. We have a pattern where we develop the science and then some other country develops the products and markets them, and this may be sort of the last chance for America to figure out why that pattern has been so dominant since the 1960s. And if we don't figure that out together, the country will be far the poorer.

I hope that we can, by talking together, understand what it is that's missing, what is apparently beyond the immediate reach of the focus of American corporations, that we can, by cooperating, do together. And the government has a large role to play in that because, ultimately, certainly government is at its simplest, simply what we do together.

So I hope that in these conversations, our witnesses will be able to direct us towards what we might do together, what we can add from our side to what strengths and capabilities and resources exist on the other sides of the American puzzle that we can put this together and succeed in an area that is so important to the future of the country.

Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentleman from Pennsylvania.

The Chair recognizes the distinguished gentleman from California, Mr. Mineta.

Mr. MINETA. Thank you very much, Mr. Chairman. I just want to thank you very much for your leadership in calling this full com-

mittee hearing. Representing part of the Silicon Valley, I know that we have the technical knowledge and the technical skills to be able to really forge ahead in this area. The question is whether or not we have the will to do it.

So it seems to me that at long last, the United States is now in a position to be winding up ready to make its pitch. The question is: Will we be dazzling our competitors with our ability to come from behind with a technological fast ball or are we going to balk the runners—Japan and Europe—into scoring position?

And so, as has already been pointed out, we can no longer sit back and wait to play catch-up and then cry that we just can't do it. So here we have, I think, in our country the ability to attain and maintain a leadership position in this industry and I am looking forward to hearing from our witnesses, Mr. Chairman, so that they will help us in understanding the issues so that we might be able to formulate that policy as we go into the 1990s and the 21st century in terms of our ability to be a competitive player in the world economy.

Again, thank you, Mr. Chairman, for your leadership. And I would ask unanimous consent to revise and extend my remarks.

The CHAIRMAN. Without objection, so ordered. The Chair thanks the distinguished gentleman from California.

[The prepared statement of Hon. Norman Y. Mineta follows.]

OPENING REMARKS BY
NORMAN Y. MINETA, M.C.

SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
MARCH 22, 1989 HEARING

HIGH DEFINITION TELEVISION RESEARCH AND DEVELOPMENT

MR. CHAIRMAN, THANK YOU VERY MUCH FOR CALLING THIS
FULL COMMITTEE HEARING ON HIGH DEFINITION TELEVISION.
YESTERDAY I HAD THE PLEASURE OF JOINING WITH FOUR OF MY VERY
FINE COLLEAGUES TO INTRODUCE THE HIGH DEFINITION TELEVISION
RESEARCH AND DEVELOPMENT ACT OF 1989.

THIS LEGISLATION WILL JOIN INDUSTRY AND GOVERNMENT IN A
COOPERATIVE EFFORT TO BRING ABOUT FASTER DEVELOPMENT AND
COMMERCIALIZATION OF HDTV. THE ACT WOULD DIRECT THE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY TO ESTABLISH
AND FUND JOINT VENTURES THROUGH ITS ADVANCED TECHNOLOGY
PROGRAM AT A RATE OF \$100 MILLION DURING EACH OF THE NEXT
FIVE YEARS.

HDTV IS IMPORTANT TO OUR NATION BECAUSE IT HAS THE POTENTIAL TO REVOLUTIONIZE COMMUNICATIONS, MANUFACTURING AND CONSUMER ELECTRONICS BOTH IN THE UNITED STATES AND THROUGHOUT THE WORLD.

AS YOU KNOW, MR. CHAIRMAN, I REPRESENT SANTA CLARA COUNTY, CALIFORNIA -- BETTER KNOWN TO MANY AS SILICON VALLEY. BECAUSE SILICON VALLEY IS THE HEART OF OUR NATION'S ELECTRONICS AND HIGH TECH INDUSTRIES, I KNOW THAT WE HAVE THE NEARLY ENDLESS SUPPLY OF TECHNOLOGICAL TALENT NEEDED TO FUEL THE DISCUSSION AND DEVELOPMENT OF HDTV.

LAST YEAR, DURING A SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY HEARING ON HDTV, WITNESSES FROM MY DISTRICT STRESSED THE IMPORTANCE OF PROPERLY ADDRESSING THE ECONOMIC, SOCIAL AND POLITICAL OPPORTUNITIES PRESENTED BY HDTV. ONE WITNESS -- MS. PAT HUBBARD, VICE PRESIDENT OF THE AMERICAN ELECTRONICS ASSOCIATION -- EMPHASIZED THE RIPPLE EFFECT ON OTHER U.S. INDUSTRY SEGMENTS IF WE ARE ABLE TO PUT TOGETHER A COMPREHENSIVE STRATEGY TO TAKE THE LEAD IN HDTV PRODUCTION.

OUR SEMICONDUCTOR, TEST EQUIPMENT, SOFTWARE, MANUFACTURING EQUIPMENT, TELECOMMUNICATIONS, AND COMPUTERS INDUSTRIES WILL BE DRAMATICALLY AND POSITIVELY AFFECTED BY A SUCCESSFUL ENTRY INTO THE WORLD OF HDTV. AS MEMBERS OF THIS COMMITTEE KNOW, HDTV GIVES EVERY INDICATION OF BEING AN ANNUAL \$10 BILLION MARKET BY THE TURN OF THE CENTURY. BUT TODAY, THE REST OF THE WORLD IS ACTIVELY STAKING OUT A CLAIM TO HDTV WHILE THE UNITED STATES CONTINUES TO LAG FAR BEHIND.

JAPAN'S ELECTRONICS INDUSTRY HAS SPENT MORE THAN \$500 MILLION ON HDTV AND HAS JUST ANNOUNCED A PROGRAM TO SPEND ANOTHER \$700 MILLION JUST ON THE DEVELOPMENT OF ADVANCED HDTV SCREENS. EUROPEAN CONSORTIA ARE SPENDING \$100 TO \$200 MILLION A YEAR ON THEIR DEVELOPMENT PROGRAMS.

IN THE UNITED STATES, DARPA ANNOUNCED TWO WEEKS AGO THAT 87 HIGH TECH FIRMS SUBMITTED PROPOSALS FOR THE \$30 MILLION RESEARCH AND DEVELOPMENT GRANTS. BUT IF ALL PROPOSALS WERE TO BE FUNDED, DARPA WOULD NEED SOME \$120 MILLION. AND WE NOW HAVE TWO BILLS BEFORE THE HOUSE THAT WOULD ENHANCE OUR TECHNICAL UNDERSTANDING OF HDTV AND SPEED IT INTO PRODUCTION.

AT LONG LAST, THE UNITED STATES APPEARS TO BE WINDING UP, GETTING READY TO MAKE ITS PITCH. BUT WILL WE DAZZLE OUR COMPETITORS WITH OUR ABILITY TO COME FROM BEHIND WITH A TECHNOLOGICAL FASTBALL, OR WILL WE BALK THE RUNNERS -- JAPAN AND EUROPE -- INTO SCORING POSITION?

THE CENTRAL QUESTION WHICH PLAGUES MY MIND IS THIS: WHY HAS THE UNITED STATES BEEN ASLEEP AT THE SWITCH UNTIL NOW, AND HAVE WE IN FACT TRULY AWAKENED?

WE PIONEERED TELEVISION, YET THE BROADCAST STANDARDS HAVE NOT APPRECIABLY CHANGED IN 30 YEARS. IT TOOK MORE THAN 20 YEARS, UNTIL THE EARLY 1980s, TO ADOPT A STEREO BROADCAST STANDARD AND BEGIN PRODUCTION WHEN THE BASIC TECHNOLOGY WAS AVAILABLE IN THE EARLY 1960s. WHY?

IT SEEMS TO ME THAT WE CAN NO LONGER SIT BACK AND WAIT TO PLAY CATCH-UP AND THEN CRY THAT WE JUST CAN'T DO IT. WE CAN. BUT THE CHANGES IN TECHNOLOGY ARE NOW COMING AT A RAPID-FIRE PACE. IF WE DON'T SOON HAVE THE INFRASTRUCTURE IN PLACE TO PRODUCE HDTV, HOW THEN CAN WE HOPE TO BE IN A COMPETITIVE POSITION -- LET ALONE A WORLD LEADERSHIP POSITION -- WHEN THE NEXT LEAP TO UNIFORMLY DIGITAL TECHNOLOGY TAKES PLACE.

I DO NOT BELIEVE THAT WE CAN AFFORD TO SETTLE FOR SECOND BEST IN ANY WAY, SHAPE OR FORM WHEN IT COMES TO HDTV. WE CANNOT AFFORD TO ADOPT A BROADCAST STANDARD WHICH MUST, OF ITS COURSE, BE RETROFITTED INTO THE EXISTING CHANNEL BANDWIDTHS AT THE EXPENSE OF THE QUALITY OF OUR SYSTEM. TO DO SO WOULD PUT US A QUANTUM LEAP BEHIND JAPAN AND EUROPE. NOR CAN WE AFFORD TO DEVELOP HDTV PURELY AS A SATELLITE OR CABLE SYSTEM.

I THEREFORE MUST EXPRESS MY CONCERN THAT INSPITE OF OUR EFFORTS TO ASSIST OUR INDUSTRIAL AND ACADEMIC COMMUNITIES TO GAIN A LEADERSHIP POSITION IN THE HDTV AREA, THAT WE MAY STILL LACK THE RESOLVE TO GAIN THAT POSITION. I HOPE THAT OUR WITNESSES WILL OUTLINE HOW THEY PLAN TO REACH THAT POSITION FOR OUR NATION.

MR. CHAIRMAN, THE ABILITY OF THE UNITED STATES TO , ATTAIN AND MAINTAIN A LEADERSHIP POSITION IN THIS INDUSTRY WILL BE A KEY TO OUR TRADE COMPETITIVENESS DURING THE 1990s AND INTO THE 21ST CENTURY. THANK YOU AGAIN FOR CALLING THIS FULL COMMITTEE HEARING. I LOOK FORWARD TO HEARING FROM OUR WITNESSES TODAY AND HOPE THAT THEY WILL HELP US UNDERSTAND HOW WE CAN HELP THEM GET HDTV INTO PRODUCTION IN THE UNITED STATES.

Are there any other opening statements? The gentleman from Colorado, Mr. Skaggs.

Mr. SKAGGS. Thank you, Mr. Chairman. Just very briefly, I also would like to express my thanks to the Chair for calling these hearings. There are two witnesses who will be presenting testimony later this morning that I would like to welcome because they come from my part of the world: Mr. Kingstone, the president of Fiberview Corporation—I look forward to your presentation and remarks later on—and welcome to Mr. John Sie from TCI Corporation as well.

Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentleman. Any other opening remarks?

[The prepared statements of Hon. Sherwood Boehlert and Hon. Jerry F. Costello follow.]

HON. SHERWOOD BOEHLERT (R-NY)
OPENING STATEMENT ON HDTV
March 22, 1989

Mr. Chairman:

The debate over government support for High Definition Television is of great significance because it marks one of the first serious attempts by Congress to grapple with the issue of what was once called "industrial policy."

We don't call it that anymore -- the term was somehow discredited -- but that's what we're talking about -- with picking winners and losers, and all the rest.

What's caused this revolution in the conventional wisdom in recent years is, of course, the daunting trade deficit with Japan, making that nation one we choose to emulate, although without really analyzing what it does. Waving the Japanese flag in front of the Congress is like waving a red cape in front of a bull, provoking a mad, headlong dash with an uncertain outcome.

For example, we think emulating Japan means putting more government money into American industry. But in actuality the Japanese government funds only 2 percent of industrial research compared with the 35 percent funded by our supposedly parsimonious government.

We need to ensure that the solutions we concoct for our economic ills are related to the problem.

For example, the creation of a domestic High Definition Television industry is not primarily a research and development problem. Indeed, many of our witnesses today

will be able to describe extraordinary strides they've made in inventing new technology. The problem is in finance and manufacturing and marketing, and all the government R&D funding in the world may have no effect.

I hope our witnesses today will be quite precise about what's keeping them out of the HDTV market and what the government can do to remove those specific impediments. We also need to know exactly what kind of commitment corporate America is willing to make to this new technology.

Part of that turns on the marketing question. How sure are we that this remarkable advance isn't going to turn out to be the "emperor's new TV," an illusion? I've read numerous articles on what this technology can accomplish but few on whether anyone actually wants it.

Now believe me, I understand that it's easy to scoff at new technology. Harry Warner is said to have reacted to his brother's suggestion of sound movies with the immortal line, "Who the hell wants to hear actors talk?" But history is also full of advances that found no market -- from telephones that transmit pictures to quadraphonic sound.

I offer these points as words of caution, not opposition. I've co-sponsored the Ritter and Brown bills, and I believe it's vital that we re-enter the consumer electronics market.

But I want to ensure that any steps we take are limited, targeted, premised on realistic assessments, and fully matched by industrial commitment. HDTV shouldn't simply be a

new banner under which we fight over an old agenda of anti-trust complaints and other matters that may not be relevant.

In the 1960s, we tried unsuccessfully to solve all our social ills by throwing money at them. We ought not try to solve all the economic ills of the 1980s simply by throwing money at a different group.

Thank you.

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COMMITTEE
 PUBLIC WORKS AND TRANSPORTATION
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 SCIENCE, SPACE, AND TECHNOLOGY
 SUBCOMMITTEE
 ENERGY RESEARCH AND DEVELOPMENT
 SCIENCE RESEARCH AND TECHNOLOGY
 SELECT COMMITTEE ON AGING

OPENING STATEMENT

U.S. REP. JERRY F. COSTELLO

OF ILLINOIS

MARCH 22, 1989

Mr. Chairman, one of the greatest challenges that is before our country is the effective use of technology and its application in the modern world. Research into the field of high definition television could provide the United States with a "foot in the door" in terms of competing with the Japanese and European nations in electronics technology.

Certainly, we have seen the impact that modern technology has had on the Japanese economy. To build on this, the Japanese are already far ahead of other nations in developing high definition television and are laying plans to market it worldwide. In an effort to remain competitive in this market, the U.S. has to determine its level of commitment and move forward quickly.

America's place in the television market has slipped considerably in the short span of two decades. When I was a teenager, there were over 15 U.S. companies that were competitive in the television industry. Today, there is one, Zenith Electronics, and its share opposite Sony and other giants is minor.

Today's hearing is a welcome opportunity to spread the word about television technology and capability, and to focus on our country's role in this field. Are we too far behind to catch up with our competitors, and should we look to linking this technology with other U.S. advances in an effort to successfully apply it? Or is it worth investing the time, energy and technological resources to try and reserve a piece of the market for U.S. businesses? I look forward to hearing from our witnesses today, and thank the chairman for the chance to offer my remarks.

The CHAIRMAN. The Chair is going to now begin the hearing and recognize our first group of witnesses. We have three panels of witnesses today, and the first panel consists of the Honorable Alfred C. Sikes, Assistant Secretary of Communications and Information, United States Department of Commerce; and Dr. Craig Fields, Deputy Director of the Defense Advanced Research Projects Agency in Arlington, Virginia—both distinguished and highly regarded experts in this field, and we want to welcome you in joining us this morning.

So the first one we will call on is Secretary Sikes, Assistant Secretary for Communications and Information. The Chair recognizes Mr. Sikes.

STATEMENT OF MR. ALFRED C. SIKES, ASSISTANT SECRETARY FOR COMMUNICATIONS AND INFORMATION, U.S. DEPARTMENT OF COMMERCE, WASHINGTON, D.C.; ACCOMPANIED BY DR. CHARLES RUSH, CHIEF SCIENTIST, NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

Mr. SIKES. Thank you very much, Mr. Chairman and members of the subcommittee. Thank you for the opportunity to discuss the actions and initiatives which the Department of Commerce has taken regarding high definition television.

As you pointed out, Mr. Chairman, high definition television brings together advances in video, computer, and communications technologies. It is now possible to increase the number of lines on a television screen or a computer monitor and make a variety of other technical changes to achieve better picture resolution or quality. The result is advances which some believe are as significant, if not more significant, than going from black and white to color television.

What is at stake here, however, is more than just better pictures. U.S. industrial competitiveness, communications policy, trade, and national security may all be affected by these technological and marketplace developments, and by the actions of both U.S. and foreign corporations and governments.

Earlier this month, Secretary of Commerce Robert Mosbacher told the Congress that, at the President's request, he was leading an Administration analysis of the HDTV issues facing the country and the alternatives available to deal with them.

Currently, there are at least 16 proposed ways of accomplishing the greater display resolution which is the hallmark of HDTV. The most publicized equipment was developed over the past 20 years by Japan's governmental broadcasting network, NHK, and Japan-based electronics companies. In addition to the NHK HDTV system, a prototype system is well along in development by a consortium of European companies supported by the EC's Eureka program.

Though starting much later than Japanese efforts, significant development work has been underway in the United States as well. With me this morning is NTIA's Chief Scientist, Dr. Charles Rush, who can describe in more detail some of the technical aspects of the various HDTV proposals if you wish.

Some experts have forecast that HDTV will be the consumer electronic product of the 1990s, much as the video cassette recorder and the compact disc player were the products of this decade. This is an important consideration. The United States accounts for 40 percent or more of the total world demand for consumer electronics. Today, however, no U.S.-based consumer electronics company ranks among the top 10 suppliers in the world.

In 1988, the United States incurred a consumer electronics trade deficit of about \$10.2 billion, or about 8 percent of our total 1988 international deficit of \$129 billion for manufactured goods.

HDTV presents challenges that go beyond consumer electronics; in effect, the strength and competitiveness of U.S. electronics generally. The U.S. electronics industry overall is globally competitive, but it confronts growing commercial challenges both at home and abroad. Between 1984 and 1987, for example, the United States' share of world electronics production slipped from 50.4 percent to 39.7 percent, according to statistics recently released by the Electronics Industry Association.

In the Darby Report which NTIA, the National Telecommunications and Information Administration, which is a part of the Department of Commerce, released a year ago, we projected the total sales in the U.S. of HDTV receivers and VCRs alone would reach a total of \$140 billion over the 20-year period after introduction. In that report we also detailed some of the technological and competitiveness implications of HDTV.

Additional information is contained in the extensive report which we published and submitted to Chairman Markey's Subcommittee on Telecommunications and Finance on March 3, 1986. In that report, among other things, we pointed out that the typical home HDTV set, for example, may contain some 30 times the memory chip capacity of today's personal computer. Rapid expansion of demand for HDTV sets, therefore, would also result in greater demand for semiconductors which, in turn, would have implications for our competitiveness in that key sector.

Beyond having a major on components markets, high resolution displays and related technologies are expected to be important to tomorrow's medical diagnostic equipment, computer work stations, military command systems and a number of other applications throughout the economy.

The CHAIRMAN. May I stop you there.

Mr. SIKES. Yes, you can.

The CHAIRMAN. Would you be kind enough—because I think it's important at this point—to elucidate further on that? The focus of the American people, at least at the moment, is on a better, clearer television picture. And I think you are now beginning to strike a much broader aspect of it.

Give us a little elucidation if you can, and maybe Dr. Rush can, of that particular paragraph. I quote: "Beyond having a major impact on components markets, high resolution displays,...tomorrow's medical diagnostic equipment, computer work stations, advanced aircraft control systems, military command systems, and a number of other applications throughout the economy."

Give us something on that specifically, if you can.

Mr. SIKES. Fundamentally, high resolution displays are going to be extraordinarily important in those sectors, in those product lines that I identified and product lines well beyond that.

The CHAIRMAN. Tell us why.

Mr. SIKES. Simply because people are going to want more precision, more resolution, more detail in what they view, whether they are inspecting things coming off of a manufacturing line, whether they are looking at a—I hesitate to get into weapons systems because I have Dr. Fields here who is—

The CHAIRMAN. We're going to ask him, too.

Mr. SIKES.—much more competent than I. But again, I think that whether it is manufacturing, whether it is entertainment, whether it is printing, whether it is advertising or a number of other areas, I think resolution, detail, precision, is going to be extremely important.

The CHAIRMAN. If the gentleman would yield, when we talk about the advanced aircraft control system—being a member of Public Works for 20 years, I understand that system very well—it appears to me what we're saying is that the quantum steps we could take in safety of aircraft patterns alone would be worth this effort. Is that a reasonable point to make? It's a strong point to make.

Mr. SIKES. I think that is both reasonable and strong. I think there is a leap of faith, however, and I think the leap of faith is—and I've taken it—that HDTV is going to be a technology driver, and that by engaging in these volume markets we are going to attain economies of scope and scale that are going to be important in developing the enabling technologies that will then have implications regarding the applications that we have been talking about.

The CHAIRMAN. The gentleman can proceed, please.

Mr. SIKES. Thank you.

The Commerce Department, through NTIA, is the President's principal adviser on telecommunications policy and is responsible for the development and presentation of communications and information policies for the Executive Branch.

More than three years ago, we began working on a broad range of high definition television issues. From a communications policy perspective, we have had several related concerns focused on ensuring that the country has the best possible television, and that policies which have served our nation well in providing for the dissemination of news, information, and entertainment are not compromised.

Additionally, the United States and the American people have enormous national investment in television. The 930 megahertz of radio spectrum, from 30 to 960 megahertz for example, represent one of the most sought after and, thus, valuable parts of the radio spectrum. Some 64 percent of the channels which are not used by the government are currently allocated to broadcasting.

We also have some 1,687 authorized commercial and public television stations, as well as 1,889 low-power television stations representing a capital investment alone exceeding \$37.4 billion, which is doubled by the capital investment that U.S. consumers have in television equipment.

We must not adopt a set of HDTV standards, therefore, that conflict with the goal of maintaining the strength of the current terrestrial broadcast system or which mean that HDTV services can only be received through satellite services, VCR or cable television.

At the same time, the growth of other distribution media, such as cable television, has brought even greater diversity in services choices to the public. HDTV should develop in ways which reinforce longstanding policies aimed at promoting the growth of choices and services, and not diminish any of them.

In addition to these communications concerns, we want to make sure that a broad spectrum of U.S. industry is fully aware of the potential implications of HDTV, and that was the point of our earlier studies and our earlier reports.

Recently, I had a major computer company tell me that they had not taken much of the talk about HDTV very seriously until late last year when they were trying to buy some high resolution monitors to incorporate into their computer system. The only manufacturers who responded to their request for proposals to supply these components were Japan-based, vertically-integrated companies, that also compete with them in end product markets. This dependency issue has concerned them, and it has concerned many in government involved with our industrial competitiveness, national security and related issues.

The U.S. Government will be involved in certain aspects of HDTV regardless of what this committee does or regardless of the Bush Administration review of HDTV. Spectrum allocation and television equipment standards questions will be addressed by the Federal Communications Commission. DARPA has announced its intention to fund selected R&D and underlying technologies. The possibility of other government actions are now being reviewed by the Bush Administration.

It is important that the government not get ahead of the private sector. The private sector must assess the risks and rewards of business opportunities. The private sector, in addition to doing the job in the labs, must confront distribution and marketing challenges. The private sector must weigh any reallocation of resources. We certainly do not want to stimulate a transfer of resources from a promising area of research and development to something less promising.

It is just for those reasons that Secretary Mosbacher has an Advanced Television Advisory Committee. We know that today companies are talking at the Chairmen's level about forming ventures to reassert U.S. strength in high resolution display volume markets.

The government should act to remove obstacles to private sector initiatives. Consideration is being given to possible antitrust law reforms to enable joint research, development and production. Technology is changing rapidly today. Research costs are also generally rising. At the same time, product life cycles are growing ever shorter.

U.S.-based electronics companies today do not always have the broad product repertoire that their foreign-based rivals enjoy. Our companies may also not have comparable sales volumes. What this

means is that our firms individually may be less able to amortize research costs across a broad product line.

Joint U.S. industry ventures in highly-contested global markets under today's conditions—where no U.S. firm ranks even in the top 10 consumer electronics companies worldwide—may well foster competition, not hinder it.

Additionally, there is the matter of stimulating research and development. As the Administration's recent budget proposals demonstrate, the President strongly supports federal funding for appropriate science and technology. At the same time, the administration wants to foster private sector support by making the research and experimentation tax credit permanent.

Secretary Mosbacher has also talked about the need to make certain that U.S. trade actions are sensitive to any HDTV-related activities. He stressed the importance of effective administration over antidumping countervailing duty laws and access to export markets to assure fair trade.

In conclusion, Mr. Chairman, Secretary Mosbacher stated that the Commerce Department will accord extremely high priority over the next months to developing a sound, comprehensive Administration policy with regard to high definition television.

Thank you very much.

[The prepared statement of Mr. Alfred C. Sikes follows.]

Statement of

Alfred C. Sikes
Assistant Secretary for Communications and Information
National Telecommunications and Information Administration
U.S. Department of Commerce

Before the

Committee on Science, Space, and Technology
House of Representatives

on

Advanced Television Developments

Wednesday, March 22, 1989

Mr. Chairman and Members of the Subcommittee:

Thank you for this opportunity to discuss the actions and initiatives which the National Telecommunications and Information Administration (NTIA) has taken regarding high-definition or "advanced" television -- HDTV.

HDTV in General

HDTV brings together advances in video, computer and communications technologies. It is now possible to increase the number of lines on a TV screen -- or a computer monitor -- and make a variety of other technical changes to achieve better picture resolution or quality. The result is advances which some believe are as significant, if not more significant, than when we went from black-and-white to color TV.

What is at stake here, however, is more than better pictures. U.S. industrial competitiveness, communications policy, trade, and national security may all be affected by these technological and marketplace developments -- and by the actions of both U.S. and foreign corporations and governments. It is these kinds of concerns that have taken these issues beyond the realm of engineering or entertainment, and made them the focus of high-level government attention.

Last week, Secretary of Commerce Robert Mosbacher told the Congress that, at the President's request, he was leading

an Administration analysis of the HDTV issues facing the country, and the alternatives available to deal with them. NTIA and all of the other resources of the Commerce Department are dedicated to supporting that effort, in coordination with other interested Executive branch agencies.

Currently, there are at least 17 proposed ways of accomplishing the greater display resolution which is the hallmark of HDTV. The most publicized equipment was developed over the past 20 years by Japan's government broadcasting network, NHK, and Japan-based electronics companies. In addition to the NHK HDTV system, a prototype system is well along in development by a consortium of European companies funded, in part, through the European Community's Eureka program.

Though starting much later than Japanese efforts, significant development work has been underway in the United States as well. With me this morning is NTIA's Chief Scientist, Dr. Charles Rush, who can describe in more detail some of the technical aspects of the various HDTV proposals, if you wish.

Consumer Electronics Implications

Some experts have forecast that HDTV will be the consumer electronics product of the 1990s, much as the video cassette

recorder (VCR) and the compact disc player were the products of this decade. This is an important consideration. The United States accounts for about 40 percent or more of the total world demand for consumer electronics. Over the past two decades, however, the American consumer electronics manufacturing business has attenuated to a shadow. Today, no U.S.-based consumer electronics company ranks among the top 10 suppliers in the world. ^{1/}

In 1988, the United States incurred a consumer electronics trade deficit of about \$10.2 billion, or about 8 percent of our total 1988 international deficit of \$129 billion for manufactured goods. U.S. consumer electronics exports were up last year, to \$1.2 billion, compared to \$709 million in 1987. Imports, however, stayed basically at the same level, despite the changes in the value of the U.S. dollar, and despite the trend toward more final assembly of products here by foreign-based companies. ^{2/}

As recently as 1984, about 45 percent of the consumer electronics sold in the United States were manufactured here, both by U.S. and foreign-based companies. But a surge of imports since that time has reduced the percentage of consumer electronics made and sold here below 40 percent. In certain product lines -- VCRs, for example -- almost all of the machines sold here are imported, or are the result of so-

called "screw-driver factories" where assemblies, sub-assemblies, and components made overseas are put together. In the largest single consumer electronics category -- radio and television sets -- imports accounted for about 59.3 percent of total sales last year. ^{3/} Even in the computer field, imports captured 39 percent of the U.S. domestic market, and while the United States enjoyed a trade surplus in this field overall, we incurred a substantial deficit with some countries, such as a \$4 billion deficit with Japan. ^{4/}

Electronics Sector Generally

But HDTV presents challenges that go beyond consumer electronics, and affect the strength and competitiveness of U.S. electronics generally.

The U.S. electronics industry overall is still globally competitive, but it confronts growing commercial challenges both at home and abroad. Between 1984 and 1987, for example, the U.S. share of world electronics production slipped from 50.4 percent to 39.7 percent, according to statistics recently released by the Electronics Industry Association (EIA).

During that same three-year time period, Japan's share of world production increased from 21.3 percent to 27.1 percent, Western Europe's output share grew from 23.5 percent to 26.4 percent, and that of the so-called "Four Tigers" -- Hong Kong,

South Korea, Singapore, and Taiwan -- rose from 4.9 percent to 6.8 percent of world production.

HDTV Components and Spin-Off Technologies

In the Darby Report which NTIA released a year ago, we projected that total sales in the U.S. of HDTV receivers and VCRs alone could average \$7 billion annually, and reach a total of \$140 billion over the 20-year period after introduction. In that Report we also detailed some of the technological and competitiveness implications of HDTV. 5/

Additional information is contained in the extensive report which we published and submitted to Chairman Markey's Subcommittee on Telecommunications and Finance on March 3, 1988. 6/ The typical home HDTV set, for example, may contain some 30 times the memory chip capacity of today's personal computers. Rapid expansion of demand for HDTV sets, therefore, would also result in greater demand for semiconductors which, in turn, would have implications for our competitiveness in that key sector.

Beyond having a major impact on components markets, high-resolution displays and related technologies are expected to be important to tomorrow's medical diagnostic equipment, computer workstations, advanced aircraft control systems, military command systems and a number of other applications throughout

the economy. Higher value-added products, therefore, are also potentially at risk.

Commerce Department Policy Concerns

As Secretary Mosbacher noted in his testimony last week, the Commerce Department has responsibilities -- and expertise -- to address many of the issues raised by HDTV developments.

Communications Policies

The Commerce Department through NTIA is the President's principal adviser on telecommunications policy, and is responsible for the development and presentation of communications and information policies for the Executive branch. The Executive Order accompanying the legislation establishing NTIA directed us, among other things, to:

- o "conduct and coordinate economic and technical analyses of telecommunications policies, activities, and opportunities";
- o "conduct studies and make recommendations concerning the impact of the convergence of computer and communications technology"; and,

o "develop and set forth telecommunications policies pertaining to the Nation's economic and technological advancement and to the regulation of the telecommunications industry."^{7/}

More than three years ago, we began working on a broad range of high-definition television issues. From a communications policy perspective, we have had several related concerns, focused on ensuring that the country has the best possible television, and that policies which have served our Nation well in providing for the dissemination of news, information, and entertainment are not compromised.

We particularly wanted -- and still want -- to make sure that whatever regulatory steps were taken to integrate HDTV into our existing television industry, those steps would reinforce, not undermine, our strong national commitment to providing the American public with the best possible television service.

The United States and the American people have an enormous national investment in television today. The 930 MHz of radio spectrum from 30 to 960 MHz, for example, represent one of the most sought-after and thus valuable parts of the spectrum. Some 64 percent of the channels which are not used by the Government are currently allocated to broadcasting.

That represents a very substantial national commitment of a scarce natural resource to broadcasting or, more precisely, the services which broadcasting today provides.

We also have some 1,687 authorized commercial and public television stations, as well as about 1,889 low-power TV stations. According to the latest Commerce Department estimates, the value of the broadcast industry's capital investment alone exceeded \$37.4 billion at the end of 1988. In addition, the public has well over twice that amount invested in television sets.

Television today constitutes the principal source of most news, entertainment, and information for most Americans. It is the leading source of local and regional news and public affairs. We must not adopt a set of HDTV standards that conflict with the goal of maintaining the strength of the current terrestrial broadcast system, or which mean that HDTV services can only be received through satellite services, VCRs, or cable television. That would have a major and, many believe, adverse impact on broadcasting -- and, more importantly, the service which the industry provides to the American people.

At the same time, the growth of other distribution media such as cable television has brought even greater diversity and

service choices to the public. The report which NTIA released on cable television services last year noted that industry investment was approaching \$30 billion, and that more than half of American households now subscribe to cable. 8/ HDTV should develop in ways which reinforce longstanding policies aimed at promoting the growth of choices and services, and not diminish any of them.

Assessing the Competitiveness Implications

In addition to traditional communications concerns, we at Commerce wanted to make sure that a broad spectrum of U.S. industry was fully aware of the potential implications of HDTV.

Recently, I had a major computer company tell me that they had not taken much of the talk about HDTV very seriously until late last year when they were trying to buy some high-resolution monitors to incorporate into their computer systems. The only manufacturers who responded to their request for proposals to supply these components were Japan-based vertically integrated companies that also compete with them in the end product markets. They were faced with the prospect of having to buy a key part of their overall system from their competitors.

Similar instances have been cited repeatedly by U.S. firms with respect to video displays, semiconductors and other

crucial components of their products. This dependency issue has concerned them, and has concerned many in Government involved with our industrial competitiveness, national security, and related issues.

The U.S. electronics business has the technological sophistication to compete in this evolving HDTV marketplace. Until recently, a clear understanding of what is at stake was not driving industry decisionmaking.

Communications Trade Issues

As I indicated earlier, we have been troubled by the trade issues raised in conjunction with the development of high-definition television. The United States has a large and growing electronics trade deficit. This constitutes, for example, a significant part of the \$52 billion trade deficit that we had with Japan last year.

The extensive direct and indirect support of HDTV which other governments have provided to their indigenous electronics industries has aggravated these concerns. As Secretary Mosbacher recently noted when he testified before the House Telecommunications and Finance Subcommittee, the United States has a long tradition of relying to the maximum extent possible on private enterprise. In this particular instance, however, the U.S. Government may have to act to achieve a competitive,

private enterprise solution.

Japan's Government, through NHK as well as the Ministry of International Trade and Industry and other agencies, has been a major factor in the development of HDTV to date. Several European governments have also been extensively involved in subsidizing their alternative HDTV approach. Foreign-based companies have adopted strategies to control not only their home markets, but to capture dominant shares of the U.S. market as well.

Government Policy Development

The U.S. Government will be involved in certain aspects of HDTV. Spectrum allocation and television equipment standards questions will be addressed by the Federal Communications Commission. DARPA has announced its intention to fund selected R&D in underlying technologies for defense purposes. The possibility of other government actions are now being reviewed by the Bush Administration.

It is important that the Government not get ahead of the private sector. The private sector must assess the risks and rewards of business opportunities. The private sector, in addition to doing the job in the labs, must confront distribution and marketing challenges. The private sector must weigh any reallocation of resources. We certainly do not want

to stimulate a transfer of resources from a promising area of R&D to something less promising.

It is for just these reasons that Secretary Mosbacher has an ATV Advisory Committee. And, we know that today companies are talking at the Chairmen's level about forming ventures to reassert U.S. strength in high resolution display volume markets. It is likewise important that the U.S. Government keep in mind that we are talking about high resolution displays, not just advanced TV sets.

The Government should act to remove obstacles to private sector initiatives. Consideration is being given to possible antitrust law reforms to enable joint research, development, and production. Technology is changing rapidly today. Research costs are generally rising. At the same time, product life cycles are growing shorter.

U.S.-based electronics companies today do not always have the broad product repertoire that their foreign-based rivals enjoy. Our companies may also not have comparable sales volumes. What this means is that our firms individually may be less able to amortize research costs across a broad product line. Because they are dependent on the sales of fewer products, moreover, for them product development and commercialization pose higher risks.

Joint U.S. industry ventures in highly-contested, global markets, under today's conditions -- where no U.S. firm ranks even in the top 10 consumer electronics companies worldwide-- may well foster competition, not hinder it. The presence of strong, foreign competitors, moreover, would ensure customers effectively competitive markets.

The Bush Administration has not yet determined whether legislation is needed to revise our antitrust laws. It is an area, however, that is under serious study and review.

Additionally, there is the matter of stimulating research and development. As the Administration's recent budget proposals demonstrate, the President strongly supports Federal funding for appropriate science and technology. At the same time, the Administration wants to foster private sector support by making the research and experimentation tax credit permanent.

Commerce is working closely with the Treasury Department, the Office of Science and Technology Policy, and the National Science Foundation, and played a major role in developing recommended R&D tax credit reforms.

Secretary Mosbacher has also talked about the need to make certain that U.S. trade actions are sensitive to any HDTV related initiatives. He stressed the importance of effective administration of our anti-dumping countervailing duty laws and access to export markets to assure fair trade.

Conclusion

In conclusion, Secretary Mosbacher has stated that the Commerce Department will accord very high priority over the next months to developing a sound, comprehensive Administration policy toward high-definition television.

1/ The world's top 10 consumer electronics companies, based on 1986 sales in billions of U.S. dollars (the most recent year available), are: (1) Matsushita (Panasonic)[\$15.6B]; (2) Philips/Grundig [\$10.2B]; (3) Thomson (including GE, RCA, and Ferguson brandnames)[\$6.7B]; (4) Sony [\$6.7B]; (5) Hitachi [\$6.5B]; (6) Toshiba [\$6.3B]; (7) Sanyo [\$5.1B]; (8) Japan Victor Corp. (JVC)[\$4.2B]; (9) Sharp [\$4.0B]; and (10) Mitsubishi (\$3.7B).

2/ 1989 U.S. Industrial Outlook at pp. 42-5, 42-6; 1988 U.S. Industrial Outlook at pp. 47-5, 47-6.

3/ See generally NTIA TELECOM 2000: Charting the Course for a New Century 609, 630-34 (GPO, 1988).

4/ See 1989 U.S. Industrial Outlook at pp. 26-1, 26-2. Imports would have been even higher if 100 percent tariffs had not been in effect on imports from Japan of certain laptop and desktop computers. These tariffs were imposed due to the failure of Japan to meet requirements of the U.S.-Japan Semiconductor Arrangement.

5/ See L.F. Darby, Economic Potential of Advanced Television Products (Washington, D.C.: Apr., 1988).

6/ Advanced Television, Related Technologies, and the National Interest (NTIA, 1988).

7/ Executive Order 12046, sections 2-412, 2-403, 2-406 (3 CFR 158, 160 (1977 comp.)).

8/ Video Program Distribution and Cable Television: Current Policy Issues and Recommendations (NTIA Special Publication 88-233)(GPO, June 1988).



Advanced Television, Related Technologies, and the National Interest

NATIONAL TELECOMMUNICATIONS
AND INFORMATION ADMINISTRATION

U.S. Department of Commerce
Washington, D.C.

March 1989



THE SECRETARY OF COMMERCE
Washington, D.C. 20230

March 3, 1989

Honorable Edward J. Markey
Chairman, Subcommittee on
Telecommunications and Finance
Committee on Energy and Commerce
House of Representatives
Washington, D.C. 20515

Dear Mr. Markey:

I am pleased to submit the report which the National
Telecommunications and Information Administration has prepared
regarding high-definition television.

Sincerely,

A handwritten signature in dark ink, appearing to be "C. L. ...", written over a horizontal line.

Secretary of Commerce

Enclosure

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

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Assistant Secretary of Commerce
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Kenneth G. Robinson, Jr.
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ADVANCED TELEVISION, RELATED TECHNOLOGIES,
AND THE NATIONAL INTEREST

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

March 3, 1989

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* Copies of Appendices included in the original Report to Congress may be obtained from NTIA.

PREFACE

During 1988, the Subcommittee on Telecommunications and Finance (Subcommittee) of the House Committee on Energy and Commerce, and the Executive Branch considered many public policy issues related to Advanced Television (ATV). During the 100th Congress, the Subcommittee held a total of three hearings on the subject and hosted a two-day demonstration of eight ATV systems. This report on ATV, related technologies, and the national interest, was prepared by the National Telecommunications and Information Administration (NTIA) of the Department of Commerce in response to a request from the Chairman of the Subcommittee following hearings conducted in September, 1988.

During 1987, the Commerce Department began a broad assessment of the implications of ATV technologies. As initial groundwork for this undertaking, NTIA commissioned a study by Darby Associates, entitled Economic Potential of Advanced Television Products ("Darby Report", April, 1988) which explored the market and public policy implications of the introduction of a range of products which incorporate ATV technologies (See Appendix A). Subsequently, the Department announced the formation of an Advisory Committee on ATV to advise the Secretary of Commerce on the impact of ATV on the competitiveness of U.S. industry, the policies that might be pursued to encourage the development of ATV in the public interest, and the communications policy, trade, and other commercial interests that may be affected.

In accordance with the mandate of its Charter, the Department of Commerce's Advisory Committee on ATV issued a Preliminary Report to the Secretary of Commerce incorporating its findings and recommendations to date (See Appendices B and C) in January, 1989, but the Advisory Committee has not issued a final report. Moreover, on December 16, 1988, NTIA published a Notice of Inquiry with respect to HDTV production standards, seeking public comment by March 1, 1989, on what the U.S. position should be regarding a production standard or standards for HDTV as we approach the upcoming meeting of the International Telecommunication Union's International Radio Consultative Committee (CCIR) in 1990 (See Appendix D). Significant attention has been given to the subject of ATV and related technologies on an inter-agency basis within the Executive Branch. NTIA's Administrator, the Assistant Secretary of Commerce for Communications and Information, has also been serving as an ex officio member of the FCC's ATV Industry Advisory Committee.

Given the ongoing nature of these activities and many other developments, this report contains information responsive to issues of interest to the Subcommittee, but it does not represent a final assessment by NTIA of these subjects and issues.

EXECUTIVE SUMMARY

The development of high definition or advanced television (ATV) represents the convergence of video, computer and communications technologies. Its import for the Nation is far greater, however, than just a better home television picture. The potential economic and strategic implications of the development of ATV and related technologies are great.

An analysis of the impact of the advent of the technological applications of ATV thus must consider the communications, competitiveness, trade, and national security policy interests at stake. An analysis must also consider not only the consumer electronics industries affected, but the semiconductor and computer industries and the many other industries utilizing these technologies, from entertainment to medical diagnosis to computer-aided design. This report should contribute to that process.

The potential size of U.S. and world markets for ATV-related consumer electronics products alone -- receivers and VCRs -- is expected to be quite large. World markets for these products will be shaped significantly by the volume and timing of purchases in the United States, expected to represent one-third to one-half of the total world market. Within 20 years of introduction, over 90% of U.S. households may purchase an ATV receiver and almost three quarters a companion VCR. The cumulative value of the household market thus could exceed \$100 billion within 20 years.

A very important determinant of the Nation's long-term competitiveness is the type and quality of jobs generated by the introduction of ATV products -- or not generated here if the United States fails to become a significant participant in the primary R&D and production of ATV products, and becomes instead merely the locus for assembly of high-technology components owned and produced elsewhere. The heart of ATV is advanced technology, which will quite likely be a significant driver of future innovation, and the source of new manufacturing and engineering spin-offs.

Advanced television technologies, like computer and semiconductor technologies, will eventually affect many major lines of commerce, with technological and strategic implications throughout the economy. Access to and significant involvement in the development of the critical technologies underlying the production of ATV products has the potential to confer significant advantages in a broad range of upstream, downstream and collateral product and service lines. Strategically, ATV products and technologies can be regarded as significant components in the development of intelligent consumer and

commercial tools accessing a vast array of services to individuals and organizations -- public and private.

Electronics and related products make up a large and growing share of U.S. commerce and world trade. The impact on trade of U.S. consumer spending on ATV products will be subject to many of the same forces combining to determine the impact on competitiveness, national income and domestic employment. Clearly, the size of the ATV products market in the U.S. alone makes it potentially a very substantial entry into future trade accounts. Governments and industries in countries that we count among our major trading partners have clearly outlined and are pursuing coordinated strategies designed, in part, to capture dominant shares of the U.S. market, while providing home sanctuaries for their domestic producers.

There are two key standards issues involving ATV that will need to be resolved. They are adoption of 1) an ATV production standard which would facilitate the application of ATV technology, perhaps as a substitute for film and a means of program exchange, and 2) an ATV transmission standard that would be used to introduce ATV technologies into the video broadcast realm. ATV production standards which are under consideration are significant for two basic reasons. First, production standards directly affect the costs for and the ability of program producers to distribute programs internationally. Second, production standards can provide a strategic gateway to the domestic and international marketplace for particular manufacturers of production equipment and consumer electronics. NTIA has initiated an inquiry on ATV production standards, seeking public comment on what the U.S. government position should be regarding a production standard or standards for ATV.

The adoption of an ATV transmission standard will also have major significance for the United States, in two related respects. The selection of an ATV transmission standard will determine the key elements in the design and manufacture of the next generation of television receivers, VCRs, and media transmission equipment. It also has the potential to change the competitive balance between the various media in the U.S.

In the past several months, the Department of Commerce has profited from the insights of key industry leaders, academics and senior level government executives provided through the Secretary of Commerce's Advisory Committee on ATV. The January, 1989 Report of the Advisory Committee includes among its findings and recommendations to date:

The issues surrounding the development of advanced television technologies present serious problems for the United States. There is only a small and dwindling industrial base in consumer electronics production in

the U.S.... If U.S. industry does not participate significantly in ATV, this situation will be exacerbated, and the U.S. will grow even more dependent on foreign-owned sources for consumer electronics.

The potential problems associated with a lack of significant U.S. participation in ATV go far beyond traditional television sets.... These technologies, in sum, are critical to the future growth and competitiveness of the nation.

It will take cooperative efforts between private industry and the government to ensure effective U.S. participation in ATV.... Considering the importance of ATV, and its effects on related industries, it is vital that the U.S. participate significantly in ATV.

We conclude that several dimensions of our national interest will be advanced by broad scale participation of U.S. firms in the technical development and market application of advanced television technologies. Moreover, it appears that combinations of technical expertise and business acumen in other parts of the world have been successfully forged, in some cases with varied and substantial public assistance, thereby creating a formidable economic challenge to U.S. firms, researchers and other public and private institutions.

It is the responsibility of the private sector, and particular groups of interested parties therein, to come forward with appropriate business plans that include specific recommendations for government actions designed to overcome current barriers to the development of a stronger U.S. presence in these developing markets. This approach recognizes the primacy of the responsibility of the private sector, while ensuring that government participation has a substantial opportunity of actually helping advance the national interest.

I. INTRODUCTION

The growing body of literature describing the development of new video and imaging related products is marked by a bewildering array of new terms and acronyms. This paper, which is a broad policy overview, will ignore, for purposes of brevity, many of the finer engineering and/or commercially based distinctions. Instead, it will focus broadly on the implications of a variety of advances in electronic visual technologies (EVT) with applications and importance throughout our economy and, more specifically, on particular home entertainment applications that will lead to the introduction of new advanced television (ATV) products into television production studios, and into the home,

such as receivers, cameras, video cassette recorders (VCRs) and the like.^{1/}

Research and development streams in several diverse areas are being combined to form a pool of new video, visual and image-related technologies, EVT, from which numerous companies, domestic and foreign, are developing applications that will lead to a diverse array of new and improved consumer, commercial and industrial end-products.

EVT embraces both old and new technologies. Much of the potential for new video and advanced imaging products is drawn from developments in computer sciences -- components, software and systems. Thus, some of the same technological developments that have made possible well-known and dramatic advances in telecommunications and data processing -- higher capacities, higher speeds and lower costs -- are being applied to creating, recording, processing, storing, distributing and displaying visual images. The principal technological components of EVT may vary, depending on the specific application or product involved. However, the key components include innovations in video display technologies, digitization of video signals, advanced signal compression algorithms, very large scale integrated circuits, application specific integrated circuits and assorted software developments.

The technological building blocks comprising EVT can be variously configured to create a variety of new and/or improved video and imaging-related products.^{2/} These product configurations range from computer workstations through a variety of devices related to the home-video entertainment market.

Thus, in assessing the national interest, the introduction of advanced television technology and products should be considered in the context of, and as a subset of, a broader stream of

1/ References to ATV in this Report thus encompass all those systems often referred to as high definition television (HDTV) and enhanced definition television (EDTV).

2/ For example, combining new liquid crystal display technologies with miniaturized electronic video components yields a wallet-sized television receiver. Combining larger versions of these with processing/memory chips and specialized software will yield an array of training and simulation devices, or computer aided design equipment, or video-medical aids for surgeons, or a variety of control panels and displays or equipment used in radar detection, tracking, and interception. Further combining these components with state-of-the-art video signal processing (most notably data compression) techniques will permit distribution and display of very high definition (static or moving) visual images.

advanced video technologies which have home entertainment delivery implications, but also, and perhaps more importantly, a broad spectrum of non-entertainment applications in commerce, industry and government. These technologies are outgrowths of research and development efforts in several discrete, but related, areas which have opened the door to a broad range of other new products involving the storage, processing, display, and distribution of visual information.

Advanced television (ATV) refers to any system that results in improved television audio and video quality, whether the methods employed improve or enhance the existing National Television System Committee (NTSC) transmission system, or constitute an entirely new system.^{1/} The NTSC convened in 1940, and again in 1950, to establish technical standards for production, transmission and reception of American monochromatic and color television respectively. The current U.S. terrestrial broadcast system adheres to the NTSC standard; i.e., television receivers currently in use to receive over-the-air television signals are NTSC standard receivers. The NTSC system, originally developed for monochrome (black-and-white) transmissions and subsequently enhanced to include color and stereo sound, uses 525 lines per frame, 60 fields per second, and has a 4:3 aspect (width-to-height) ratio.

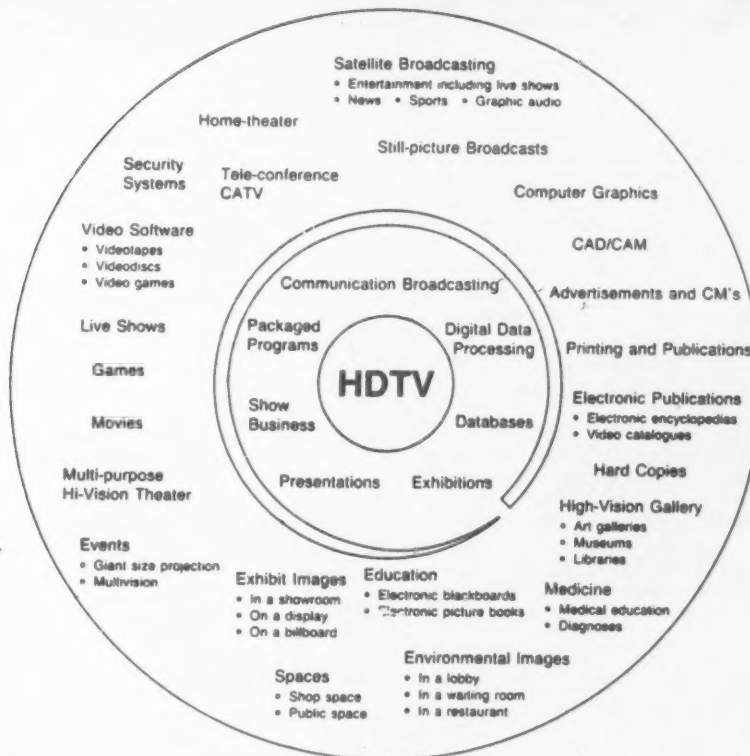
Essentially, all ATV systems substantially improve one or more of the key visual/aural characteristics of NTSC television: horizontal and vertical resolution as defined by the number of video lines in the signal; color fidelity and picture sharpness; the ratio of picture width to picture height (the "aspect" ratio); sound fidelity; motion rendition; and the elimination of a variety of imperfections or "artifacts" in image rendition, such as, for example, backward spinning wagon wheels and smudged or bleeding colors. ATV systems generally can be expected to provide video quality more comparable to 35mm motion pictures, with more than twice as much information per frame as the NTSC standard (for example, over 1000 lines with a 16:9 aspect ratio).

ATV connotes applications which initially are largely consumer oriented, principally, the delivery of entertainment television to the home. Initially, consumer applications of ATV technologies will involve goods and services supporting the home entertainment market, including a diverse array of new equipment suitable for the production, distribution and display of much higher quality video images and sound from dramatically improved television receivers and videocassette recorders. These will incorporate a variety of other incremental improvements over

^{1/} See, e.g., Definition of ATV adopted by the Federal Communications Commission, Notice of Inquiry, MM Docket No. 87-268, 2 FCC Rec. 5125 (August 20, 1987), Par. 19.

conventional television picture qualities. Some ATV systems will make it possible for viewers to enjoy a "theater like" experience with stereo sound and 35 mm film fidelity displayed on a wide screen receiver in the home.

Despite this consumer product orientation, the nonentertainment applications of ATV-related technologies outside the home are likely to be both substantial and quite diverse. Many new products and services which are not associated with entertainment delivery will require the use of video images of very high resolution, clarity and fidelity. High resolution video imaging technologies are coming into increasing use in several nonentertainment applications in both the public and private sectors, including, for example, computer work stations, satellite photography, remote sensing and monitoring, command and control displays, surveillance and security, medical diagnostics and numerous others. See, for example, the following excerpt from a recent promotional document describing many applications of the Japanese "Hi-Vision" HDTV system:



There is currently considerable developmental activity centering on the task of bringing ATV products to market as quickly as possible. Major efforts are taking place in Western Europe and Japan. Efforts in the United States began later and thus far are on a significantly smaller scale. Japanese electronics firms are ahead of their counterparts in Western Europe. American-owned firms trail both. Eleven Japanese firms are licensed to manufacture under Japanese patents and the first imported consumer products are expected to be available here in 1990. Advanced, professional studio and production equipment from Japan is already available and in use in the United States. Products from Western European-controlled companies are expected two years or so after import of Japanese consumer products begins. No production schedules have been announced by American-owned firms.

There will be a close relationship between the development of the ATV consumer electronics marketplace and the development of broader EVT markets, for commercial, industrial and even military applications, because of the overlap of technologies and the similarity of components required for the manufacture of products in these categories. Both consumer electronics and a wide range of other video technology-based products will likely contain large numbers of similar semiconductors and will utilize technologically-similar display devices.

Most of the prototype ATV products appear to be semiconductor intensive. For example, a typical prototype high definition television receiver may have five or more chips for analog/digital conversion, six or more chips for processing, and eighteen or more memory chips. Similar picture tubes, or possibly flat-panel displays, will be utilized in both ATV consumer electronics and broader EVT products. The production of ATV consumer products for sale in the U.S. market will provide demand for semiconductor production in sufficient volume to create a significant potential competitive advantage for firms which will produce semiconductors and display devices for both ATV consumer electronic products and other EVT products.

Advanced television technologies and products, in short, appear very likely to be critical "drivers" for a broad range of video and image related industries in the future.

In some quarters, there is a discouraging level of pessimism about the potential for U.S. participation in developing advanced television products. Some observe gloomily that we have only a single U.S.-owned company making TV sets, while characterizing our position as being way behind and anticipating that it would take a long time to "catch up", without defining exactly what that means. Recently, some have suggested that any attempt to reassert U.S. commercial participation in video consumer electronics might even hurt the consumer or the broadcast and cable industries. They apparently reason that it is primarily

foreign companies that have the necessary talent and resources to provide good components or end products.

NTIA rejects such pessimism. First, many of the technologies that will be essential to the next generation of TVs are also essential parts of the computer industry. The U.S. has world-class strength in computers.

U.S. companies are also strong in research and development work in flat panel display technologies. There is a significant body of opinion that supports the proposition that the market for ATV receivers may not truly "take off" until flat panel displays are available. The Defense Advanced Research Projects Agency recently announced its intention to stimulate further research and development on display technologies and recognized explicitly its benefits for the consumer electronics market.

Additionally, much of the foreign-based R&D has been aimed at markets with dramatically different wants and needs. The Japanese and the Europeans, for similar and different reasons, have pointed almost exclusively toward satellite to home ATV. Neither has either the massive investments in terrestrial distribution systems we have or the history of localized news and public interest programming aimed at serving a diverse population occupying about 3.7 million square miles.

Whether a combination of U.S. companies or U.S. and international companies combine to develop further ATV products for the U.S., adequate time is needed. While quite useful, most of the existing research and development on ATV has been aimed at satellite distribution. Present R&D is and future R&D will be aimed to a large degree at meeting the transmission standard criteria outlined by the FCC. Fortunately, the information tools which today shorten product life cycles also accommodate steep and rapid learning curve ascents. There is reason to believe, therefore, that unless unduly handicapped, U.S. companies will have an opportunity play a key role in delivering the next generation of television to consumers in the United States and internationally.

The remainder of this report attempts to summarize as concisely as possible the results of NTIA's work to date on these issues, including the contributions of participants in the Secretary of Commerce's ATV Advisory Committee and other industry input.

II. ATV AND THE U.S. ECONOMY

Some of the potential effects on the U.S. economy of the introduction and diffusion of ATV-related consumer electronics products are relatively direct and amenable to rough estimation. Others are more strategic in nature, difficult to quantify, and

deal with questions of technological leadership, industrial competitiveness, national defense and other issues. This section addresses the potential direct effects of the development of an ATV-related consumer electronics market in the United States on the national economy. In this regard, estimates of the potential size and value of ATV markets are discussed. Moreover, because worldwide demand for ATV consumer electronics products will generate significant amounts of income and employment in participating countries, these implications, as they may play out in the United States, are summarily discussed as well.

A. Indications of Potential Market Size

The potential size of the U.S. and world markets for ATV-related consumer electronics products, in particular receivers and VCRs, has been estimated by several independent analysts. The world market for these products will be shaped significantly by the volume and timing of purchases of ATV-related products by households in the United States, a market that is expected to constitute between one-third and one-half of the total world market.

Several factors will combine to determine the rate of diffusion of ATV-related products in this, and other, countries. Key elements underlying consumer demand for these products include the prices, quality and introductory timeliness of new ATV product lines; consumer incomes and their general acceptance of new ATV products; the availability, quality and prices of complementary products/services (software, programming, distribution media, and the like); and, very importantly, the content and timing of equipment and spectrum standards adopted by the relevant governmental entities. There is therefore significant uncertainty about how quickly this market will develop. Nevertheless, most analyses indicate that the potential market is quite large and that, given the right conditions, market penetration in the United States and elsewhere in the world will be quite rapid.

An obviously key factor is the widespread availability in the market of equipment and infrastructure necessary to distribute and receive ATV programming. Though studio production equipment embodying high definition television technologies is now available in the United States, equipment necessary for the distribution and display of higher resolution television images is not. Japanese sources have indicated that such products will be available within two years. Others believe that receivers with high definition capability will not be widely available in the United States until somewhat later. No one seriously

disputes the conclusion that some product will be available worldwide very early in the decade of the nineties.

Another important factor for the U.S. market in particular, where television today still relies substantially on local over-the-air broadcasting, will be the timing of adoption by the Federal Communications Commission of a transmission standard governing ATV broadcasts. Completing the testing and evaluation program planned to date and adopting a standard can be expected to take two to three years. Even though nonbroadcast distribution of ATV formatted programming can proceed via video cassettes/players, as well as through existing (but re-engineered) coaxial cable networks, substantial consumer acceptance and purchase of ATV receivers likely will be delayed until ATV sets are able to receive program material on over-the-air signals.

Price and consumer perceptions of the quality of ATV products will, of course, be instrumental in shaping the pace and pattern of household diffusion. Product prices will have to fall substantially from their expected introductory level if high household penetration is to be achieved. However, the economics of ATV production are expected to display falling costs (from both scale and learning economies) over time and as market volumes mount. Extending recent historical trends in consumer electronics market behavior indicates the likelihood of continued growth of household expenditures on so-called home entertainment products and services. Continuation of this trend strongly suggests consumer buying patterns capable of supporting widespread and rapid diffusion of new ATV related household entertainment products.

Large screen (projection) televisions now make up about two percent of the market in the United States. Market penetration of these video sets has been hindered by their relatively high price, the poor quality of their image resolution and the household space requirement for large screen viewing areas. Early ATV receivers will have much better picture quality, but will be hampered, to some extent, by the other disadvantages. Similar obstacles to widespread consumer acceptance existed at early stages in the development of other new electronics products, including NTSC television (both color and black and white), calculators, computers, and compact discs. Market forces over time established mass markets in each of these cases.

A recent study performed for the Department of Commerce by Darby Associates, Economic Potential of Advanced Television Products ("Darby Report, April, 1988, Appendix A), explored the determinants of diffusion of ATV products and constructed scenarios of potential market development derived from data describing the growth histories of other consumer electronic product lines. Growth of the U.S. household market for ATV related products, television receivers and VCRs, was simulated by

reference to the domestic development of markets for conventional color televisions and VCRs, home computers, satellite receiving antennae, stereo audio systems and very large screen, projection television receivers.

By compositing the market histories of the sample product lines, a "representative" growth path for ATV receivers and VCRs was constructed. This approach to visualizing potential future market demand suggests that one percent household penetration of these products might be achieved within 6-8 years after product introduction. Within fifteen years following introduction, the simulation indicates that over 50% of U.S. households may be using ATV products (television receivers and/or videocassette recording/display devices). Within 20 years after introduction, if the history of household adoption of early generations of entertainment-related consumer electronics products is an adequate guide, over 90% of U.S. households may purchase an ATV receiver and almost three quarters of them may also own a companion VCR.

Other studies of the development of ATV-related product markets have recently been made public. They are quite consistent on the major points with the results of the Darby Report, although there are some variations in detail. A study performed under the auspices of the Electronic Industries Association (EIA) concluded that ATV products would achieve one percent U.S. household penetration (about a million units) by 1994, or three to four years earlier than in the Darby Report. In contrast, a working document proposed by a Task Force of the American Electronics Association (AEA) projected that one percent household penetration would not be achieved until 1999. Twenty-five percent household penetration is anticipated before the turn of the century by EIA and by the year 2005 in the AEA Study. The Darby Report estimate for twenty-five percent penetration is midway between the AEA and EIA estimates.

B. Indications of Potential Market Value.

The Darby Report analyzed the conditions underlying consumer acceptance of ATV products and describes two contrasting diffusion scenarios.^{4/} In the "sluggish" diffusion scenario, the cumulative value of sales of receivers and VCRs, over a fifteen year period after introduction, falls within the \$1 to \$5 billion range, depending on the pattern of product prices during that time.^{5/} In the "rapid" diffusion scenario, the cumulative value

^{4/} See Darby Report, Appendix A, pp. 30-38.

^{5/} This estimate assumed average product prices of \$1500 for ATV VCR's, and \$2500 for ATV receivers.

of sales reaches the \$25 to \$51 billion range over a fifteen year period, again, depending on the pattern of product prices over the period.

The dollar value of the rate and level of household penetration in the "rapid" diffusion scenario seems likely to be quite substantial under reasonable valuation assumptions. Assuming "rapid" diffusion and using the midpoint of high and low estimates reported for combined cumulative total sales in the Darby Report, it appears that the cumulative value of the household market for ATV receivers and VCRs could reach nearly \$40 billion within fifteen years and exceed \$100 billion within twenty years after introduction.^{6/} The same method suggests that annual sales may reach \$10 billion fifteen years after introduction and over \$15 billion within twenty years.^{7/}

C. Potential Domestic Income and Employment Effects.

The potential impact on national income and pressure on domestic employment of this level and value of realized U.S. household consumer expenditure may reasonably be expected to be substantial.^{8/} To the extent that the national economy is "fully

^{6/} See Darby Report, Appendix A, Table 12, p. 36.

^{7/} One of the least-appreciated implications of the development of ATV technology is that it provides an entire new generation of economic value to existing film production libraries. For example, an entire new generation of video cassettes are likely to be created from the existing movie library in the new ATV format, although the approximate value of this market is yet to be determined.

^{8/} The Darby Report (Appendix A, pp. 41-44) contains an analysis of potential employment impacts utilizing employment multipliers for domestic production of consumer electronics products taken from a study conducted by Arthur D. Little for the Consumer Electronics Group of the Electronics Industries Association. The analysis was based on two assumptions: (1) the entire value added in the production of these products is the result of economic activity in the U.S., i.e., there are no imported components or materials and no offshore fabrication; and (2) production processes will not become less labor intensive over time. Given the limitations posed by these assumptions, the Darby Report does not forecast levels of employment. The analysis merely illustrates the powerful potential effects that domestic ATV value added could have on domestic employment. It is important to bear in mind that the nature of any impact on domestic production of ATV products on national income and employment will be influenced by the extent to which the economy is at that time "fully" employed. Depending on the amount of "slack" in the

employed", the possible emergence of ATV product markets as characterized above, will change the composition of employment by attracting labor from other sectors. Under such circumstances, the force of any additional demand on domestic resources would be manifest in the level of prices and in the composition of national employment and output.

The actual impact will be conditioned further by several factors. These include the "domestic content" of products sold here and abroad, contemporary labor utilization patterns, utilization rates and productivity, and the degree of substitution or complementarity among new and old product lines. None of these factors can now be foretold with great confidence.

The proportion of domestic content of ATV products is of clear importance, because the location of production of ATV products will determine in considerable measure the direction and magnitude of the potential impact on domestic economic activity. While the limiting cases, zero and one hundred percent, will not obtain, the actual value is critical, but very difficult to estimate.

Even though world markets for consumer electronic products are currently dominated by foreign-owned firms,^{9/} some of these companies have acquired or located production facilities in the United States, and those companies may selectively use U.S.-produced components in assembling final products in this country or elsewhere. Thus, despite the limited ownership by U.S. commercial interests of the means of producing these products, U.S. content of today's television receivers is not insignificant. However, U.S. content will be subject to a new set of forces after the introduction of an ATV line of products.

The large size and fragile nature of large screen picture tubes will tend to promote some production and assembly of current television receivers in the United States (and in Mexico and Canada for export to the United States), despite foreign ownership of most of the companies involved. Since ATV receivers will likely have larger screens, in order to maximize consumer perception of improvements in picture quality, we can expect an increased incentive to manufacture these picture tubes and assemble the finished sets in North America. On the other hand, another of the technologies being developed, flat screen displays, may at some point permit hanging a television screen on

economy, the principal effects may be on the composition of income and employment rather than on their respective levels.

9/ Zenith Corporation is the only current U.S.-owned contender in world markets for television receivers, and there is no domestic firm engaged in the production of VCR's.

the wall, rather like a mirror or heavy picture frame. It is quite possible that applications of this technology to the production of large screen sizes will be technically and economically feasible by the time ATV takes off in the domestic marketplace. This technology will undoubtedly alter the weight and size constraints that now influence a company's choice of whether to produce or assemble the product geographically close to the locus of final consumption.

If ATV does achieve a high consumer acceptance rate in the United States, the extent or pattern of utilization of the U.S. labor force is assured to change. Between 10,000 and 25,000 jobs will be created in ATV-related industries, for every \$1 billion in final sales of ATV products, according to Commerce Department estimates. The number of U.S. labor employment opportunities created in ATV-related activities will depend on, among other things, the extent to which U.S. or foreign firms locate production facilities on U.S. soil, labor productivity, and other factors. Subject to similar considerations, the United States economy will enjoy the benefits of multiplier effects on income and employment in other sectors related to the production of ATV and related products/services in this country.

A very important determinant of the Nation's long-term competitiveness is the type and quality of jobs generated by the introduction of ATV products -- or not generated here if the United States fails to become a significant participant in the primary R&D and production of ATV products, and becomes instead merely the locus for assembly of high-technology components owned and produced elsewhere. The heart of ATV is advanced technology, which will be a driver for future innovation, and the creator of new manufacturing and engineering spin-offs. Specifically, it is expected that many of the jobs linked to ATV will be not only challenging and rewarding, but that they will also encourage the development and maintenance of skills vital to future U.S. competitiveness throughout the economy. They will require and incorporate graduate level expertise in mathematics, the sciences, and the advanced engineering disciplines. Jobs in this category, on the cutting edge of science and technology, will foster a work environment of creativity and innovation that will be the driver of future advances in technology and its applications.

III. STRATEGIC IMPLICATIONS OF ATV AND RELATED TECHNOLOGIES

The sum of several broader, if more diffuse, effects is even more critical to the national interest than the direct economic effects discussed above. Development of markets relying on applied electronic visual technologies will be quite different from many more familiar markets like, for example, textiles,

conventional consumer electronic products or even automobiles. In its technological and strategic implications and its interrelationships with other markets throughout the economy, EVT should be viewed more in line with the computer and semiconductor industries. In the case of ATV products, it is difficult to quantify the external effects which nonetheless will eventually pervade and be generated in almost every major line of commerce. Access to and control of the critical technologies underlying the production of ATV products has the potential to confer significant advantages in a broad range of upstream, downstream and collateral product and service lines.

EVT will have important impacts on the semiconductor industry, the computer industry, and on industries utilizing computer and television display technologies. These impacts are separately discussed below. In addition to these impacts, linkages in the network of information markets and industries make it probable that the U.S. market for ATV products will have important upstream and collateral effects spreading throughout the electronics and information industries. ATV technologies related to visual display devices will create important spillovers into computer work stations, various office products and other communications technologies like videotext and video-conferencing. As a practical matter, the potential spillovers will be constrained only by user preferences and production economics, and not by any inherent limitations of the technologies involved.

The introduction of EVT and ATV products ought to be viewed as a new, cornerstone element of the evolving infrastructure of the "information age". The technology is in large part a video application of computer technology wherein television images, rather than data, are converted to digital bit streams and back to images. Strategically, ATV products and technologies can be regarded as significant components in the development of intelligent consumer and commercial tools accessing a vast array of services to individuals and organizations -- public and private.

A. Potential Commercial and Industrial Impacts

Impact on the U.S. Semiconductor Industry. The semiconductor is a key bridge between markets for ATV products and other lines of commerce. The technologies now being perfected and applied to ATV products are semiconductor intensive. For example, the NEC prototype ATV receiver is reported to contain five chips for conversion between analog and digital signals; six processing chips; and 18 memory chips. To convert a signal using the leading Japanese ATV technology to make it compatible with the U.S. base of installed television receivers would require a converter consisting of four circuit boards, which will in the

future be composed of five VLSI chips. The Electronic Industries Association of Japan estimates that 32 megabytes (MB) of Dynamic Random Access Memory (DRAM) capacity will be required for each receiver. The capacity of these individual HDTV receivers can be compared to the 1 MB of internal memory currently incorporated into the Apple Macintosh Plus.

One indication of the potential commercial importance of this bridge is apparent from a statement of the Electronic Industries Association of Japan in November, 1988. Referring to the enormous capital investments now being funneled into Japanese DRAM capacity, the Association explained that the investments are based on "a conviction that demand -- especially for memory chips -- will grow and stabilize with the introduction of new end products using much larger quantities of DRAMs." In that context the Association cited many of the electronic visual technologies discussed in this paper, including, quite notably, ATV receivers and computer workstations.

ATV market dominance, or even large scale participation, will confer significant advantage in the production of current and future generations of semiconductors. Most of the world's manufacture of consumer electronic products is controlled by integrated firms that also produce a variety of components, including semiconductors. In 1986, for example, about one-third of Japanese semiconductors were used in their consumer electronics sector. Indications are that this share is growing. In contrast, shipments of the U.S. semiconductor industry to the consumer electronics sector have been declining in recent years; and during 1986 apparently accounted for only about 5-6% of U.S. semiconductor output.

These indicators are significant because there are a variety of important synergies between the level of ATV-related products manufacturing, upstream sales of semiconductors and, further upstream, semiconductor materials and manufacturing processes.

The following relationships have been documented:

Scale economies in semiconductor production are more readily attainable in the presence of high volume demand from the consumer electronics sector;

To the extent that common production processes are used, the cost of semiconductors for other uses will be lower as a result of the high volume demand from the consumer products sector;

The cost of R&D for a wide range of commercial, industrial and governmental applications can be amortized across the consumer-electronics driven base;

The fairly stable demand for consumer electronics products can provide insulation from the more volatile demand for semiconductors from other sectors;

Cost advantages will accrue to favorably positioned suppliers by virtue of both economies of vertical integration and economies of scope;

Horizontally diversified and vertically integrated firms can use revenues from the consumer products and semiconductor lines to contribute to development of new processes and new products both upstream and downstream;

High volume production of semiconductors gives rise to "learning" economies which increase the proportion of circuits that function, thereby driving down the average cost and price of salable output;

Impact on the U.S. Computer Industry. The U.S. enjoys today world-wide advantages in computer hardware and software. For example, Apple, IBM, DEC and COMPAQ products are sold world-wide, even in Japan. But Japan has made significant strides in the computer industry and many of the U.S. advantages in this area are eroding. All U.S. computer companies, even IBM, depend on their foreign competitors, especially Japanese firms, for a substantial number of key components such as DRAMs. The independence and competitiveness of the U.S. computer industry is threatened by this dependency.

The impact of such dependency was vividly illustrated by the effect of the DRAM shortage and price increases which occurred in 1988. The shortage forced computer production cuts at a majority of U.S. computer companies and led to substantial price increases. Particularly affected were the small U.S. companies without long term contracts and with little bargaining power.

EVT production will give the vertically integrated competitors of the U.S. computer industry further significant advantages in technical know-how and economies of scope. One result might very well be further erosion in key semiconductor component areas not presently under foreign control, such as application specific integrated circuits, analog to digital converters, microprocessors and low-noise, fast gallium arsenide logic devices. These components are, of course, key building blocks for a wide range of "information age" products.

Thus, a lack of U.S. participation in the ATV and EVT markets will, many believe, exacerbate the problems of the U.S. computer industry and threaten its hardware base. A recent AEA Working Document concluded that failure of U.S. producers to attain a "strong" position in the U.S. HDTV market could result in loss of

as much as half of what U.S. manufacturers' share of world computer markets would otherwise be. Similarly, a "weak" position in HDTV products could, according to AEA, lead to further dramatic erosion of the semiconductor market share of U.S. firms. The AEA study also indicates that participation of U.S. firms in the HDTV market has significant spillover effects in markets for automated manufacturing equipment (AME)--robotics equipment, process control equipment and CAD/CAM components.

Impact on Industries Utilizing Computer and Television Display Technologies. As indicated above, a key bridge between the advanced television products market and markets for other electronics products is the semiconductor. It is important to note in this context that the success of other U.S. government efforts (its role in Sematech, for example) to buttress the domestic semiconductor industry may be lessened if large portions of the world market for consumer electronic products--including ATV products--are controlled by vertically integrated foreign manufacturers of semiconductors. That will clearly be the case if, as in the past, these firms tend to purchase semiconductors from their own affiliates and/or resident manufacturers.

Furthermore, control or dominance in the market for consumer television products will spill over into the market for picture tubes and ultimately into the next generation of flat panel displays. No U.S. plant is currently able to manufacture an ATV picture tube or flat panel display for broad-based consumer electronics applications. The Japanese Ministry for International Trade and Development (MITI) has announced its support (with \$54 million) of 12 Japanese manufacturers aiming to develop and market by 1994 a large, flat LCD color display for use in ATV products.

There are about a dozen or so U.S. producers of flat panel displays for military and commercial applications. Yet, a recent study by the International Trade Commission reported that none of them indicated any intention of entering the consumer display market, because of the perception that Japanese companies had already tied up the end user market and would not be likely to buy display-related product from U.S. sources for incorporation into Japanese manufactured television sets. Since such displays are likely to be less bulky and lighter weight than conventional television tubes, there will be less economic incentive to produce them near the locus of final consumption.

The advantages conferred in the market for displays by large volume sales in the consumer products area are, for reasons similar to those discussed above in the context of semiconductors, amenable to being leveraged to advantage in the production of a broad range of commercial and industrial products requiring video or image displays. Economies of scale, scope and learning associated with large ATV display production volumes

will confer potential advantage in other closely related markets. Much of the R&D expenditure for advance displays is, and will be, common to a range of different product lines and can, accordingly, be amortized in a variety of ways that confer substantial competitive and strategic pricing flexibility.

B. Implications for National Security

There are several specific defense applications of ATV technologies, including: intelligence images and high quality dynamic displays; high fidelity simulator displays; large command center displays; multi-media systems including television as a data type and a variety of classified systems. The Defense Department has indicated that the trend toward convergence of defense-related and commercial applications of EVT/ATV technologies and products can lead to significant economies in Department acquisitions. The Defense Department has also expressed concern over the increasing dominance of the principal technologies and components they require for a wide variety of defense applications by offshore firms. A recent Defense Science Board Task Force concluded that dependency on foreign sources for state-of-the-art electronics technology "...is an unacceptable situation."

C. International Trade Implications

Electronics and related products make up a large and growing share of U.S. commerce and world trade. The rapidly changing composition of products exchanged in this sector reflects the extraordinary dynamism of the underlying technologies. Some products now accounting for a large part of the volume and value added did not exist a mere decade or so ago.

1. Trade effects

The impact of U.S. consumer spending on ATV products on trade will be subject to many of the same forces combining to determine the impact on competitiveness, national income and domestic employment, as discussed above. Clearly, the potential size of the ATV products market in the U.S. alone makes it potentially a very substantial entry into future trade accounts. The extent to which ATV products are produced in the United States, rather than offshore and imported, could have a significant influence on the size and composition of the trade balance. If the economy is "fully employed", the locus of production--here versus offshore--will influence mainly the composition of trade with less impact on the trade balance. In either case, the stakes for the U.S. national interest are great if the market materializes as many believe it will.

The history of the U.S. color television market may foreshadow the prospects for U.S. interests in markets for advanced television products. There has been an endless stream of controversy and litigation over the past two decades on the relationship between Japanese strategic trade and industrial policies on the one hand, and the nearly complete demise of a once robust U.S. color television receiver and consumer electronics industry on the other.

The controversy has ranged from a Treasury Department finding of Japanese television "dumping" in 1970, through a consent agreement entered with the International Trade Commission in 1977 (wherein five Japanese manufacturers promised not to engage in illegal trade practices in the U.S. or to interfere with U.S. firms selling color televisions in Japan), to a 1986 U.S. Supreme Court decision on an antitrust conspiracy case (decided in favor of Japanese companies 5-4, largely on a test of federal rules of evidence rather than on a test of the merits).

As projected from current trends and apparently differing national priorities, future participation of U.S. companies in domestic and foreign markets for ATV products clearly risks being next to negligible. Governments and industries in countries that we count among our major trading partners have clearly outlined and are pursuing coordinated strategies designed, in part, to capture dominant shares of the U.S. market, while protecting home sanctuaries for their domestic producers.

2. Activities of Major Trading Partners

The tremendous strategic importance of participation in the U.S. ATV market has been recognized by the European Economic Community ("EEC") and by the government of Japan. Firms in Japan and Europe, with substantial assistance from their respective governments, have seriously pursued opportunities in ATV-related products and have made the U.S. consumer market a major target of their efforts. Japanese and European interests are competing vigorously to have their respective national standards adopted in the United States and in international settings, in order to gain advantage in the enormous and pivotal U.S. marketplace. Japanese firms maintain they will begin exporting HDTV products for distribution in this country by 1991. European-owned firms are expected to have products available approximately two years later. Both appear prepared to enter U.S. HDTV markets well before any U.S. counterparts.

Japanese Activities. Japan's National Broadcasting Company (NHK), a quasi-governmental entity, began developing HDTV technology about seventeen years ago. They have given the private sector at no cost 3 transponders to make possible public broadcasting. In addition NHK has transferred its HDTV technology to private sector firms in Japan at no cost to the

recipients. The value of NHK's HDTV research and development is estimated to be approximately \$500 million. Private sector firms in Japan are developing commercial products with this technology. Tax incentives and promotional support have also been made available to help develop uses for HDTV.

Private manufacturers in Japan joined the NHK effort some six or seven years ago. According to a recent Government of Japan estimate, "private" spending on the development of HDTV products has been as much as \$400 million. Major manufacturers--including Sony, Toshiba, Hitachi and Matsushita--indicate a readiness to market HDTV receivers and VCR's in 1991. All manufacturers reported that, because of economies of scale afforded by the combination of the Japanese and American markets, entry into the U.S. market will be a top priority and a major factor in the final cost, market prices and long term marketing strategy.

Japan's Ministry of Post and Telecommunications (MPT) is actively promoting the acceptance of HDTV throughout Japan by sponsoring demonstrations and designating "hi-vision" cities to receive government support and tax relief to initiate HDTV projects--theaters, for example. In addition, MPT is offering assistance for software development, promoting utilization of satellite transponders for HDTV by private broadcasters, and supporting research directed to improving the technology.

These promotional efforts have been supported financially by various government and private sector sources. For example, MPT's efforts have been augmented by private sector contributions from the Broadcast Technology Association. This has been accomplished through plans for a loan program for the development of HDTV assisted by the Long Term Development Bank; and, through the efforts of Japan's Ministry for International Trade and Development (MITI), which has established an HDTV Promotion Center and loan program through the Long Term Credit Bank to assist businesses starting out in HDTV production or distribution. The Japanese Diet has established a 100 member committee to ensure a continuing stream of government oversight and funding for the development of HDTV.

European Activities. A coordinated, pan-European approach to ATV commenced in the Fall of 1985. This approach appears to be an outgrowth of talks between major manufacturers, notably Philips (The Netherlands) and Thomson (France), which first became apparent at the May, 1986 meeting of the International Radio Consultative Committee (CCIR) in Dubrovnik, where the Europeans blocked adoption of a world-wide production standard based on Japanese technology. Following the 1986 CCIR meeting, the European Community initiated and funded an extensive research and development program called "EUREKA-95". The purpose of the program was to develop a full-range European ATV alternative to the Japanese entry. The driving force for this initiative has

been the desire of European television and related equipment manufacturers to hold the large European market and, if possible, capture a major share of the American consumer ATV market.

From recent discussions between U.S. and European representatives, it is estimated that \$100 million has been spent on the EUREKA-95 Project. That amount is divided roughly 60/40 between the private sector and government sources. The Europeans have clearly recognized the broad significance of ATV development. The President of Thomson International told U.S. representatives that consumer electronics utilized about one-fourth of all European semiconductors. European administrations and the Community are apparently firm in their resolve to protect European receiver manufacturers against Japanese competition, while simultaneously competing vigorously with Japanese manufacturers in the wide open American market.

A recent article in the Economist contains some insight into the logic of the Europeans:

"The (Japanese) idea was simple: to make the conventional television obsolete. The new TV sets would be stuffed full of chips, not only improving picture quality but benefitting Japan's components industry at the same time....As HDTV has come nearer to market, the television makers' reasons for deploying it have become more urgent....(Due to intense competition from elsewhere in Asia) the Japanese and European consumer electronics giants need HDTV to keep in front."

On October 10, 1988, French President Mitterand proposed to EEC Commission President Delors that the EEC endorse the launching of an "Audiovisual Eureka" which would have as its objective the creation of European programming for television, and which would pool efforts with the Eureka-95 HDTV program. At the Rhodes EEC summit meeting early this month, a detailed eight point program for the Audiovisual Eureka project was unveiled which clarified that a primary purpose, in addition to promoting programming, is to "devise the technical means" whereby the European ATV standard "can be demonstrated and promoted." An EEC official stated to U.S. officials in December that a primary purpose of the Audiovisual Eureka would be to help speed up the commercial introduction of European ATV studio production and programming equipment.

The Europeans claim that their system is technically superior to the Japanese system. In any event, the two are clearly incompatible. The EEC is now engaged in a coordinated publicity and marketing campaign directed toward gaining acceptance of the

European concept worldwide, but particularly in the United States.

Other Countries' Activities. Canada adheres to the NTSC standard, and it has been a strong supporter of the Japanese-based system for studio production and program exchange. Canada has more recently initiated a joint government/private sector committee to examine ATV. Moreover, two Korean firms recently acquired Japanese HDTV technology. As part of the agreement permitting Japan's NHK to broadcast the 1988 Olympic Games from Seoul using HDTV, NHK agreed to sell HDTV technology to Korean firms. Two Korean firms, Goldstar and Samsung, have paid a nominal fee for the technology.

IV. CHALLENGES OF ATV TECHNOLOGIES FOR COMMUNICATIONS POLICY

A. The Significance of Standards

It is important to distinguish between two distinct, but related, types of ATV standards currently at issue. First, there is the production standards, standards which determine the manner in which audio and visual information is recorded to create an ATV program. Production standards are applied to the design and manufacture of production equipment, e.g., studio cameras and video tape recorders/players. Second there are transmission standards, standards which determine the manner in which ATV programs are distributed to viewers after they are produced. For example, after a program is produced in an ATV format, it might be distributed to viewers via terrestrial television broadcasting, cable television, satellite, or videocassette. Each of these distribution media have limited though different bandwidth in which audio/video information must travel, and, essentially, the transmission standard is the basis for compressing the information into a format which conforms to the bandwidth limitations of distribution media. Transmission standards are applied to the design of transmission equipment, e.g., broadcast transmitters and cable headend facilities, and to the design of ATV receivers and VCRs.

Production standards are significant for two basic reasons. First, production standards directly affect the costs for and the ability of program producers to distribute programs internationally. Second, production standards can provide a strategic gateway to the domestic and international marketplace for particular manufacturers of production equipment and consumer electronics. The United States has supported a single worldwide production standard that would facilitate the distribution and exchange of video programming. However, the European nations have opposed the adoption of this international production standard which is based on technology originating in Japan. While Japan's long term commitment to develop ATV has been well-known for some time, the Europeans appear to have been galvanized

by the realization that the world was about to embrace the Japanese-originated production standard. The Europeans are convinced that adoption of this standard will impose severe competitive handicaps on European production, distribution and display equipment at home and in the vast U.S. market -- a market in which they aspire to achieve substantial penetration in furtherance of their strategic objectives.

The adoption of an ATV transmission standard will have major significance for the United States in two related respects. First, the selection of an ATV transmission standard will determine the key elements in the design and manufacture of the next generation of television receivers, VCRs, and media transmission equipment. Second, it has the potential to change the competitive balance between the various media in the U.S. The United States presently has over \$100 billion in embedded investment in current television technology, and ATV enhancements will ultimately require that much of this equipment be replaced.^{10/} With current technology, the existing terrestrial broadcasting system in the United States could be precluded from competitively offering ATV programming. Consequently, many of the challenges inherent in selecting a transmission standard for the United States pertain to: (1) compatibility of transmission standard alternatives with the existing NTSC standard; and (2) feasibility of transmission standard alternatives for implementation by terrestrial television broadcasters.

B. Production Standards

The value of ATV technology has been recognized in the United States by the film and television program production industry. Not only does ATV offer images with high quality 35mm film-like resolution, but it also holds the potential for substantially increased speed and flexibility in program production, post-production editing and program distribution. Also, ATV offers substantial potential cost savings as compared to film, both in direct production and in numerous other aspects of the film development and distribution process.

When ATV's advantages were recognized, there was a strong desire in the program production community to develop the technology and to work toward establishing standards. In this regard, the industry has in the past benefited from the existence of a common

^{10/} The rate at which replacement will be necessary will depend on a number of factors, such as availability of product, price and the degree to which the new transmission standard is compatible with the current NTSC standard. If the new technology is accepted by the public, sales of ATV receivers and VCR's in the U.S. alone could exceed \$140 billion in the next twenty years, according to the Darby Report.

internationally accepted standard for film. Based on years of ATV research in Japan, the Japanese submitted, together with the United States and Canada, a recommendation to the 1986 Plenary Assembly of the International Radio Consultative Committee (CCIR) -- the organ of the International Telecommunication Union responsible for recommending voluntary technical standards for radio communications -- that their standard be adopted as a worldwide production standard for HDTV.

Since 1985, the United States has supported the establishment of a single worldwide HDTV production standard. This position was adopted for the May 1986 Plenary Assembly of the CCIR. The Plenary Assembly did not reach agreement on the recommendation, however, as the Western European nations opposed the use of a 60 Hz standard. Instead, the Plenary Assembly agreed to study the matter further and to reconsider the issue at its next plenary session, scheduled for 1990. While the standard was not adopted by the CCIR, the U.S. has continued its support for a single worldwide production standard. Study Group 11 of the CCIR will hold an extraordinary meeting on HDTV progress in May 1989 in preparation for the next Plenary Assembly.

As indicated, a primary reason for U.S. support of the 1125 line, 60 Hz HDTV production standard proposed in 1985-86 has been the desire to have a single worldwide standard. Current television transmission systems throughout the world use incompatible standards. For example, in countries like the United States, Japan, and Canada, a 60 fields per second system is used; in contrast, Western Europe, Eastern Europe and the U.S.S.R. use 50 fields systems. It was hoped that a worldwide HDTV standard could be established at the Dubrovnik Plenary so that there would be compatibility of television production systems which would ease the transfer of programming among nations. The sale of programming is a major export industry for the United States.

The Western Europeans, however, refused to accept the proposed system and successfully blocked its adoption by the CCIR as a production standard. They argue that adoption of that standard could make the existing television receivers in Europe obsolete since they operate on 50 fields per second, while the system based on NHK's research uses 60 fields per second. Instead, the Europeans began work on their own HDTV system -- called Project Eureka -- which uses 50 Hz.

Despite the reluctance of the Western Europeans to accept the proposed standard, many U.S. interests continue to advocate the support of it. Moreover, other members of the international community continue to support the establishment of a single, worldwide production standard regardless of origin. For example, at the request of the U.S.S.R., representatives from major groups met in Moscow in September to discuss prospects for a single worldwide production standard. The meeting looked at three

possible standards for a worldwide production standard. Representatives of the Soviet Union have informally communicated with European representatives that the Europeans should not assume the Eureka HDTV system will be acceptable in the USSR or the Eastern Bloc. Moreover, the Soviet Union has proposed testing of the Japanese and Eureka technology and systems in Moscow.

Representatives and interest groups from European nations are actively lobbying key U.S. organizations and individuals to revisit the earlier standards determination. Meanwhile, the NHK-derived system is the only production standard in use which is supported by available equipment.^{11/} Until recently, there have been no alternatives, either U.S.-developed or developed by any other nation.

One area of potential technical concern affecting the viability of a single production standard has arisen recently. It is based in the cycle rates of the production equipment and the power supply in the locales where production is undertaken. Apparently, when 60 cycle production equipment is used to film lighting running off a 50 cycle power source, it produces a strobing effect on the video image being recorded. Given the nature of video technology, however, this trouble is immediately visible on the video screen. The problem apparently can be fixed by rewiring a set to provide a 60 cycle power source. The same would also hold true for any 50 cycle camera shooting in a 60 cycle electric power environment. Conceivably, there could be a software or hardware solution, but, until clarified, this could present an unacceptable limit on the universal acceptance of any system as a worldwide production standard. Significantly, unlike objections based in various nations' industrial policies, this seems to be a potentially material technical problem that will likely require a technical solution.

In December, 1988, NTIA issued a Notice of Inquiry ("NOI") on the HDTV production standards, seeking public comment on what the U.S. government position should be regarding a production standard or standards for HDTV at the upcoming meeting of the CCIR in 1990.^{12/} The NOI noted circumstances which have changed since 1985 which require careful analysis based on a current record. It indicates, for example, that it is unlikely that a

^{11/} NHK-based production equipment is currently being manufactured and distributed, and programming is being produced in HDTV. For example, the major theatrical movie "Julia, Julia" was shot in HDTV and then transferred to 35mm film. Other programming, including commercials and music videos, is also being produced in HDTV.

^{12/} See NTIA NOI on HDTV production standards, Appendix D.

single, worldwide HDTV production standard will be agreed to. In addition, the NOI takes account of other production standards now under development, and raises certain questions concerning the technical feasibility of a single standard. The NOI seeks public comment on, among other things, the criteria that should be used in deciding to support a production standard, the relationship between the production standard and the transmission standard for HDTV, and the relationship between production standards and the equipment producers attempting to serve end user markets.

Transmission Standards

ATV technology must be adapted to various program distribution media because virtually all media have limited bandwidth for the transmission of the audio and video information which constitutes ATV programming. ATV production formats use over 100 megahertz within a closed wire system. Other video distribution media are significantly constrained either by physical or economic limitations. Consequently, there is a practical necessity to employ signal processing and compression techniques. For example, terrestrial broadcasting in the U.S. today is licensed to use only 6 megahertz. Additionally, even closed wire systems, such as cable television, while not as limited by spectrum concerns, are not free of such constraints. Both Japanese and European developed systems are oriented toward direct satellite to home delivery of ATV signals. Yet cable television systems in the U.S. today pass over 85% of all household and serve over 50% of the public. Terrestrial over-the-air broadcasting in the U.S. remains our dominant medium, even accounting for 50% of the programming retransmitted over cable systems. Essentially, each distribution medium poses unique issues with significant implications for how ATV will develop and the nature of this country's video environment in the 21st century.

Terrestrial Broadcasting. Of these alternative transmission media in the United States, terrestrial broadcasting is unique in that its transmission standard is regulated and constrained by government. The FCC's rules require that a television broadcast station use only a 6 MHz channel, an aspect ratio of 4 to 3, and transmit 525 scanning lines per frame -- the NTSC standard. Although other media currently use this standard, they are not required to do so and, within their technical capabilities, are free to adopt new standards. Broadcasters, however, have to seek a change of FCC rules and may need to acquire additional scarce spectrum in order to transmit ATV.

The United States is in a unique position in regard to the establishment of a transmission standard. First, the United States represents approximately 40% of world television receiver demand. Thus, a transmission standard adopted for the U.S. market will have a substantial impact on world television equipment markets. Second, while both the Japanese and Europeans

intend to deliver ATV programming to their homes via satellite transmission, the backbone of the U.S. television industry is terrestrial broadcasting. Broadcasting in the United States, due largely to this country's great land mass and heterogeneous population, is based on federally fostered principles of localism, which encourage responsiveness to issues of local importance.

The FCC has recognized that if terrestrial broadcasters are not allowed to transmit ATV programming, broadcasting could become disadvantaged vis-a-vis other media and public interest benefits of localism would be jeopardized. The local video marketplace is most competitive when all media outlets are free to utilize state-of-the-art technology. It is not easy to maintain competition, however, when marked technical quality differences between competitors are imposed by regulatory constraints.

In 1987, therefore, the FCC initiated a proceeding to develop an advanced television (ATV) transmission standard for terrestrial broadcasting, and established an industry Advisory Committee to look into related questions. NTIA will continue to assist the FCC in these important efforts.

It is unclear exactly when the FCC will be in a position to establish a transmission standard for terrestrial broadcasting. There are currently numerous systems in development, but, as with the HDTV production standard, only the NHK system -- developed by the Japanese Broadcasting Corporation -- has been extensively field tested so far. The FCC's Advisory Committee is planning to begin field testing of other systems in 1989. That testing should last one to two years, depending on the number of systems presented. It is highly unlikely that the FCC will set a transmission standard until that testing is completed and the results have been thoroughly reviewed.

Cable Television. Cable ATV development is likely to be stimulated by the fact that many see ATV as a vehicle by which cable could develop a significant, sustainable, competitive advantage vis-a-vis other video distribution media, particularly broadcasting. If cable were able to offer substantially higher quality ATV programming compared to its competitors, the growth and revenue effects could be substantial.

Cable television has somewhat greater flexibility with respect to the technical aspects of selecting an ATV transmission format. Because cable transmits its signal to the home over a closed wire system, it has the flexibility to reconfigure its bandwidth, subject primarily to constraints dictated by television receivers and channel capacity of the cable. Cable service typically requires the use of cable-ready television receivers, or the use of a company-provided signal decoder box. The ability to customize decoder boxes may provide flexibility in addressing the

NTSC compatibility issue. Nevertheless, the cable industry is mindful that the most advanced ATV transmission systems to date, NHK and Eureka, were developed for direct broadcast satellite (DBS) distribution and may not be as well suited to cable. Even if these transmission systems are adaptable, however, there is support in the cable industry for developing an ATV transmission system specifically designed for cable.

ATV presents the cable industry with significant issues. While cable has greater flexibility than terrestrial broadcasting in configuring spectrum bandwidth, it is not unconstrained. Many cable systems currently do not have excess channel capacity; introducing ATV signals in excess of 6 megahertz will come, therefore, at the expense of reducing the number of other signals provided to cable customers, a significant economic constraint. This will be especially relevant if the cable industry finds it necessary to transmit programming in both NTSC and ATV formats simultaneously.

The enhanced resolution quality of ATV technology is expected to be relevant to virtually all of cable's program service offerings. Movie channels such as Home Box Office and Showtime, and sports services such as ESPN, may be among the first cable services to offer ATV programming for cable systems. Approximately 50% of the programming transmitted on cable now involves the retransmission of over-the-air broadcast television signals, however, and retransmission of these signals remains important to cable companies, broadcasters and cable subscribers.

Overall, it is still too early to tell how the cable industry will respond to the ATV challenge. Some leading national cable concerns have indicated an intent to emphasize enhanced resolution (EDTV), as opposed to full high definition (HDTV), television. It is conceivable that multiple ATV standards could develop for the cable industry. This would almost certainly require that there be a failure to agree upon a terrestrial broadcast ATV standard within the relevant time period. Establishment of an ATV broadcast transmission standard would be expected, at least initially, to have a substantial effect moving cable toward the same, or at least a compatible standard. This would be true even though that standard would likely be designed to maximize television receiver performance within broadcasting's constrained spectrum environment.

Video Cassette Recorders. In addition to complementing broadcast and cable reception of ATV, video cassette recorders (VCRs) are thought to be the most probable route for Japanese and other manufacturers initially to introduce ATV into the U.S. On a technical level, VCRs are not constrained by spectrum availability or the channel capacity of cable systems. ATV-compatible VCRs may be introduced into the U.S. market, for example, using the NHK/Muse format developed for ATV transmission

via DBS in Japan. The Japanese will soon begin volume production of ATV receivers for DBS reception and have announced that they will produce and make available ATV VCRs and video disc players.

One possible strategy within the U.S. marketplace which has been discussed foresees Japanese companies waiting for neither a terrestrial broadcast nor cable TV industry standard. Instead, they could begin to market ATV receivers (that would be compatible with both ATV and NTSC programming) and VCRs together in the United States in a much shorter time frame. One condition to success in any such strategy would be the availability of ATV programming. This might be accomplished to some degree by initially encouraging, even subsidizing, use of compatible ATV production equipment to produce new programming. Even more significant, however, might be efforts made to encourage conversion to ATV video cassettes of existing motion picture libraries, perhaps by buying a U.S. motion picture studio and film library.

Direct Broadcast Satellite. Video program distribution in the United States via direct broadcast satellite (DBS) is an anomaly. The potential to provide television programming to the home via satellite has long been recognized and has been authorized by the FCC for several years. However, while many potential DBS providers have expressed interest the U.S. does not yet have a formal DBS service in operation. On the other hand, satellite transmission of video program material is extensive and has become a critical element in both the cable and broadcast industries for internal and program distribution purposes. What has been impressive, however, is the unanticipated growth and popularity of home satellite dishes capable of receiving these signals. Thus, an informal DBS system is flourishing in this country, particularly in rural areas where people have shown a willingness to invest thousands of dollars in dish antenna systems in order to have access to a broad array of program choices. This informal DBS system was formalized somewhat by the Cable Communications Policy Act of 1984 (Cable Act) which authorized such home dish viewing for private use and also authorized sale and distribution of encrypted services directly to the home.

Internationally, much of the world is moving toward DBS as a way to distribute programs inexpensively over large areas. DBS is being developed both as a primary national video distribution medium and as a supplement to existing terrestrial systems. Significantly, both the NHK/MUSE and Eureka ATV transmission systems are designed for DBS.

With respect to the United States, introduction of ATV via DBS, particularly if done on a relatively exclusive basis, could provide DBS with an edge helping to drive DBS growth. Whether or not this will happen will depend on a number of developments,

such as the rate of adaptation by cable operators and broadcasters. In any event, there are a number of potential DBS participants, including broadcasters and satellite manufacturers, who are taking a hard look at this area where the opportunity might be significant.

Fiber Optic Transmission of Video Programming. When discussing possible video transmission media for the future, particularly over the time frame during which ATV is expected to develop, the potential for delivering video programming to the home over fiber optic facilities should be considered. Besides representing an alternative very high capacity, high quality medium, the ability to deliver ATV programming in this way may in turn spur the installation of such advanced facilities to residences across the country. Existing cable television companies, today using coaxial cables of varying ages and capacities, may upgrade replacement facilities with fiber optics. New cable entrants may choose fiber for their initial builds.

In addition, the market likely to develop for ATV programming plus other video services, and therefore additional transmission capacity, may encourage telephone companies to install fiber optic cables and advanced switching and other equipment over the "last mile" of the telephone network, the portion running into homes all across America. Serious legal, regulatory and policy issues surrounding telephone company participation in the video marketplace are being debated elsewhere.^{13/} But such facilities might in the future ameliorate some of the limited spectrum or channel capacity availability problems which today face prospective ATV developers.

V. CONCLUSION

As indicated in the preface, this report does not represent a final assessment by NTIA of the subjects and issues discussed herein. However, in the past several months, NTIA has profited from the insights of key industry leaders, academics and senior level government executives provided through the Department of Commerce's Advisory Committee on ATV. The January, 1989 Report of the Advisory Committee includes among its findings and recommendations to date:

The issues surrounding the development of advanced television technologies present serious problems for the United States. There is only a small and dwindling industrial base in consumer electronics production in

^{13/} See, e.g., Video Program Distribution and Cable Television: Current Policy Issues and Recommendations, NTIA Report 88-233, June, 1988.

the U.S.... If U.S. industry does not participate significantly in ATV, this situation will be exacerbated, and the U.S. will grow even more dependent on foreign-owned sources for consumer electronics.

The potential problems associated with a lack of significant U.S. participation in ATV go far beyond traditional television sets. ATV sets will be heavily dependent on semiconductors. With the projected aggregate sales of ATV sets, their production will create a large demand for semiconductors. If U.S. semiconductor manufacturers do not have significant access to this market, they will be severely disadvantaged relative to their vertically integrated competitors. Besides the semiconductor manufacturers, it will also affect the upstream feed technologies and their respective industries -- materials manufacturers, instrument and equipment manufacturers. Likewise, ATV development and production will also impact dramatically the computer industry, as the two industries increasingly rely on similar technology. ATV will also affect many other fields and industries which use visual imaging, such as medicine, printing, and video program production, as well as many national security applications. These technologies, in sum, are critical to the future growth and competitiveness of the nation.

There are several factors which have led to the decline of U.S. competitiveness in consumer electronics.... The time lag in establishing standards for ATV has given U.S. industry a window of opportunity to become involved in manufacturing ATV products....

It will take cooperative efforts between private industry and the government to ensure effective U.S. participation in ATV. The nature and extent of such efforts is still under consideration by the Advisory Committee. Some members of the Committee have stressed that this Report should even more strongly characterize the issues and further emphasize the urgency of a concerted effort to respond to the international challenge we face on the ATV issue. Considering the importance of ATV, and its effects on related industries, it is vital that the U.S. participate significantly in ATV.^{14/}

^{14/} The January, 1989 Report of the Secretary of Commerce's Advisory Committee on Advanced Television is included in its entirety as Appendix B.

We conclude that several dimensions of our national interest will be advanced by broad scale participation of U.S. firms in the technical development and market application of electronic visual technologies generally, and advanced television services and products more particularly. Moreover, it appears that combinations of technical expertise and business acumen in other parts of the world have been successfully forged, in some cases with varied and substantial public assistance, thereby creating a formidable economic challenge to U.S. firms, researchers and other public and private institutions.

The principal responsibility for meeting that challenge resides, of course, clearly and irrevocably within the private sector. If we are to project successfully our substantial economic and technological prowess, and in this area it is substantial, we must recognize in the first instance that the entrepreneurial wherewithal, labor skills and capital assets for doing so reside in the private sector. They must be, and they are being mobilized.

At this point, it is not productive to debate whether or to what extent the United States is "behind" in the international race to develop and market advanced television applications of electronic visual technologies. The driving force behind the need for a more concerted and intense U.S. effort is not to play "catch-up", but rather to ensure the timely availability of technology and high quality products and services that are compatible with our unique domestic communications infrastructure and national needs. ATV products and services being developed elsewhere in the world do not currently and clearly pass that test. There is also a question as to whether the most often discussed ATV systems are state-of-the-art or, if so, whether they will be for very long. A substantial and varied U.S. presence in these markets is also necessary as a means for ensuring that a broad array of U.S. firms will enter the 21st Century as world class competitors in the provision of products that are located upstream, downstream and collaterally with respect to advanced television products.

Ultimately, the government will face the question of what, if anything, it should do to assist the path being traced in a dozen or so domestic laboratories and in a handful of U.S. boardrooms. The combined results of several NTIA initiatives, undertaken over the past eighteen months, indicate that there is a substantial prospect that our current course will not result in a technological, economic and commercial outcome fully consistent with the U.S. national interest.

We have been told by various people in industry and government, for example, that:

- the current application of the antitrust laws is unduly restrictive of potential joint efforts by U.S. firms necessary to achieve a critical mass able to compete successfully in global markets;
- government needs to encourage, or even to take the lead in establishing and funding, a consortium of interested private sector partners;
- asymmetrical trade practices between the United States and some of our major trading partners need to be reconciled;
- capital costs and the opportunities for risk sharing are substantially less congenial in the United States than in other countries of the world;
- applications of current U.S. tax policies fail to encourage, and frequently discourage, firms to undertake risky investments in R&D and in other areas that are necessary to ensure full participation in EVT markets;
- that in the past, incentives have encouraged our companies to focus technology efforts toward defense related products without also encouraging additional non-defense applications of the same technologies; and,
- a wide variety of other conflicting Federal policies combine to discourage a variety of salutary private sector, commercial initiatives that otherwise would advance the U.S. interest.

In response to the foregoing, it is our view that any appropriate government actions should be carefully targeted to the specific barriers to furthering our national interests in this area. Moreover, any government initiatives should be tailored to specific needs arising from specific private sector initiatives. The expenditure of federal tax dollars in support of vaguely conceived or poorly designed individual or joint private sector ventures would be not only ill-advised, but quite likely counter-productive.

It is the responsibility of the private sector, and particular groups of interested parties therein, to come forward with appropriate business plans that include specific recommendations for targeted government actions designed to overcome current barriers to the development of a stronger U.S. presence in these developing markets. This approach recognizes the primacy of the responsibility of the private sector, while ensuring that government participation has a substantial opportunity of actually helping advance the national interest. It would also serve to minimize the potential for unintended, adverse effects in this, or other areas, of the economy.

As the Secretary of Commerce's Advisory Committee noted, ATV poses great challenges for both U.S. industry and government. It is clear that the issues are far more complex and important than contemplating a larger television screen or higher resolution images solely for the world of home entertainment. The Executive Branch, FCC and the 101st Congress must face the necessity of timely policymaking which takes account of the significance of ATV developments for U.S. industrial competitiveness, communications policy, international trade and national security. Domestic and international developments critical to these issues are progressing and policy options must be developed and implemented quickly coordinating these areas.

The CHAIRMAN. I thank the gentleman for his testimony. It might be profitable—but I think we'll wait until we talk with Dr. Fields—you said Dr. Rush is with you in reference to some of the technical proposals?

Mr. SIKES. Yes, sir.

The CHAIRMAN. All right. Well, let's hold that for a minute and go to Dr. Fields. Dr. Fields, we want to welcome you. Let's hear your testimony.

STATEMENT OF DR. CRAIG FIELDS, DEPUTY DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY, ARLINGTON, VIRGINIA

Dr. FIELDS. Mr. Chairman, members of the committee, I wanted to thank you for the invitation to come today. As you may know, I testified before another House subcommittee about two weeks ago on the same subject, and with your indulgence what I would like to do is to enter the formal statement that we have submitted to you into the record. I would like to make some brief remarks, summarizing what we are trying to accomplish, but then I would like to concentrate on what we have accomplished in the two weeks since I last testified, because we have made really quite a lot of progress, and I think you should know where we are.

The CHAIRMAN. With no objection, the statement will be put in full in the record.

Dr. FIELDS. I would like to start out by summarizing where I think the country will be, where the Defense Department will be in two to four years if the program we have started succeeds and goes forward as we think it will. There are five things to say.

First of all, I think U.S. companies are going to have the very best technology for displays and display components of any in the world. I've been privy to the contents of the 82 proposals and five white papers that we received, and the quality of the contents of the best of those is simply astonishing, and I was very proud to read the documents that we received.

You should realize that technology superiority is not the same as economic superiority. It is probably a necessary component but it is far from sufficient, so we look to other actions that the Commerce Department will lead in addition to our program in order to really try to deal with the larger picture and the larger problems.

Number two, we're not only dealing with product technology, but I think we have accepted the fact that we have to deal with manufacturing technology up through and including pilot lines as well. If you can't produce the stuff at a reasonable quality and cost, then it doesn't go anywhere. That is very important.

Number three, what will happen is that DoD will be able to buy higher performance display technology, including components and, through design innovation, lower cost products than we now can.

I don't know whether you are acquainted with the remarks of William Ross who is president of McDonald Aircraft, a part of McDonnell Douglas. He spoke on the 16th of March before the National Aviation Club, and what he said—and I think he said it very well—was basically that the displays we have and the aircraft they

build are sufficiently limited that they just don't allow the pilots to get the best out of those aircraft.

We asked his staff to come to Washington. They came yesterday to give us a full briefing of the background, and they showed us experimental results that they've gotten under Air Force funding comparing performance with today's display technology and improved display technology but incidentally, not as good as we hope to get out of this program, and they saw very large improvements in performance, a factor of 2.7 improvement, in fact, on some particular important tasks.

Now, that's data associated with military function and military aircraft. I don't have comparable data in the civilian realm as you were describing it, but at least there is something big and important there.

Number four, besides the DoD direct interest, I think U.S. industry is going to get some very valuable experience as a consequence of this endeavor in working together. As you know, it's the American way to compete essentially on all fronts, and that is probably a healthy thing to do in many contexts.

On the other hand, in this context maybe it is better to compete on some front and cooperate on others. Cooperate on standards, interfaces, protocols, common tools, common materials, and that all has to get worked out. But it is very expensive to compete on all fronts, and so industry is looking for new structures as to just how to deal with that. I am glad to be working with them.

And, lastly, number five, we are going to get some valuable experience working together in the Executive Branch. I have been very pleased with the relationship that has grown up between the Department of Commerce and the Department of Defense on this issue. It is a very healthy one and I hope the Congress will continue to encourage that, because we really are working together.

Now, how are we going about trying to make this all happen? Well, as you know, what we do is to fund R&D proposals from primarily U.S. industry and we, in fact, are doing that in this area. Proposals from big companies and small; proposals from companies that typically do business with defense, but mostly companies that don't. And in funding them, we're cost-sharing with industry. Industry investment, in fact, in this program will exceed ours and I am very pleased to see that.

We have received documents, proposals from teams of companies, but we need to get those teams working together even more, and so part of our value added over the next few weeks is to accomplish that by dealing with issues, as I've mentioned, like shared protocols, interfaces, shared manufacturing tools and so on.

In addition, we have to link these new activities to the ongoing technology investment that DARPA makes at the current 313 U.S. companies. That technology base of VLSI design tools, chip making facilities, CAD/CAM tools and many, many other things is really an invaluable resource to put into this endeavor, and that's part of our job and part of what we are trying to do.

In doing this, we are trying to motivate subsequent and even concurrent private investment by seeing to it that we, to the extent regulation and laws allow, assign data and patent price to the bidders, see to it that we impose no unnecessary constraints on export,

and seeing to it that we don't impose specifications on the technology developed which needlessly raise costs. That is an important business principle and that is what we are doing.

We are continuing to work with the Department of Commerce, also the FCC, NASA, NSF and other parts of the government, and we have invited the Defense Manufacturing Board to assemble a panel of industry experts, first meeting on April 13, but then meeting thereafter, I hope, as well to give us good industry advice on how we should proceed.

We are working with the American Electronics Association and other groups forming private consortia so that our R&D investment is synchronized with their activity as well as with the Semiconductor Industry Association's DRAM consortium that they are trying to get formed, to make sure again that we are working hand in glove.

With that as background and introduction, let me tell you what we have accomplished during the last two weeks, if I may. We have assembled a team. We assembled a team of 49 technology reviewers to go through these proposals from various parts of the government. Normally, we wouldn't deal with a group quite that large, but I wanted to accomplish two things. One is, of course, to involve other parts of the government than just DoD. But the other is that the technology range in the proposals we received was really broad. It covered manufacturing and electronics, electronic components. It covered material, science, optics, and we really needed a team that large in order to get the expertise to really evaluate this work.

We have looked at these proposals based on technical soundness, on their relevance for defense, potential for large-scale commercial production, manufacturing capability, availability of key personnel, quality of business plans, costs, cost sharing, all the usual criteria in, I think, a very thorough fashion.

We have also looked at these proposals from the point of view of their opportunity to form a working team that could really leverage things back and forth and not go at things one on one.

The result is that I think we now have a planned program where we can specify what will happen when, what the costs will be, and just what we are going to get out of it both in the middle of the program, at various points, as well as the end.

Out of the 82 proposals and five white papers, we have qualified 49 proposals. Most are small. Some are large. I am surprised at that number, I thought it would be smaller, but the quality was very high. In fact, if you look at any one of them, there is value added over the other 48. That is the criteria we've applied. These 49 proposals don't represent 49 companies; they represent 106 organizations because here is a lot of teaming.

In fact, there are groups sometimes involving up to 10 companies working together which are consortia, one of which, the Microelectronics and Computer Technology Corporation, is a form of consortia. So I am very pleased about that.

The proposals sort of naturally divide into the two groups that you would expect: namely, 14 qualified efforts in the display processor or receiver area; 28 qualified efforts in the display technology area; that is, displays proper, CRTs, flat panels and what have you;

and those are supported by seven small projects in manufacturing tools and manufacturing technology.

To give you a sense of the structure, because I would like you to know where we are, in the area of receivers the architectures that we've looked at cover both very specialized architectures that are optimized for high performance and the lowest possible cost; things that we're going to call video processors, that have some more flexibility and opportunity for upgrade; and things that I'm going to call video work stations where there is even an opportunity for programmability and function beyond TV, and that becomes an issue of where is the marketplace and what are people going to produce. But that whole range is nicely represented.

In the area of contributing components to those receivers, there are excellent efforts for underlying integrated circuits which I hope will be shared by a number of system builders; microelectronics packaging and manufacturing technology again shared; and lastly and most interestingly, some mathematical algorithms for dealing with the signals which just haven't been seen before and are very exciting to me.

In the area of displays, the qualified proposals include CRTs that are optimized for very low cost of production and sort of nearer-term production, include projection systems that would allow you to get very, very large displays, and include four different kinds of wall-mountable flat panel displays, each of which has some advantage over the others.

In addition, I had mentioned those seven efforts in underlying tools, most of which, incidentally, deal with the flat panel displays.

Now, what we are going to be doing next since this is a formidable group, is working with those companies, visiting some of them, having others visit us, in order to look at the critical technology, see how it can all be linked together, work with other parts of the government and Defense to see exactly who is going to fund what—because, in fact, while we are going to do certain parts of this, I have good indications that others will do other parts—and then in the near term, I hope, start signing contracts.

I am extremely optimistic about things, having gone through all this material. As I said, I think we can have the very best technology in the world, and if we couple that with the rest of the strategic plan for dealing with the larger economic issues that are outside Defense's purview, I think we'll have some real success.

Thank you.

[The prepared statement of Dr. Craig Fields follows.]

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Publication Until
Released by the
Committee

Statement by
Dr. Craig I Fields
Deputy Director for Research
Defense Advanced Research Projects Agency
before the
House Science, Space and Technology Committee
Science, Research and Technology Subcommittee
March 22, 1989

Mr. Chairman and Members of the Subcommittee on Science, Research and Technology, I appreciate the opportunity to appear before you to discuss DARPA's activities related to American industry's participation in High Definition Television (HDTV).

The Defense Department has for many years acquired high definition displays for such applications as training simulators, command and control systems, and intelligence work stations. Because of special DoD needs for high performance in its displays, until now well beyond commercial or consumer demand, we have had a focused R&D program to develop new technology for displays, display processors and man-machine interaction. In a nutshell, we have been supporting work in these areas for years.

During the last few months I received some exciting unsolicited proposals for displays and related components. These proposals could have significant Defense benefits. These proposals were based on innovative ideas and designs that could lead to much lower cost displays for Defense, even in the relatively small production volumes that the Military Services need. If the technology were mass produced, propelled by the success of HDTV, considerably greater economies would be realized by Defense. In some cases the proposals also promised greater display performance than now available from any available technology, regardless of cost or country of origin, making plausible Defense applications that have heretofore been just dreams, e.g. very large scale dynamic high resolution map displays. Finally, some of the proposed technology had application far beyond displays, e.g. to high speed digital signal processing.

I decided it would be desirable to make some hard choices, review our priorities, and reorient some of our ongoing work in man-machine interaction to accommodate these exciting new ideas, and in the interest of fairness to issue a competitive Broad Agency Announcement (BAA) to solicit proposals from those organizations that might have excellent technologies and capabilities, but not know of DARPA's interest in this area. More to the point, this is the best way I know to find out what industry can do, what industry wants to do, and what industry wants the Department of Defense to do. Incidentally, we issued our procurement only after we spent months conferring with US industry to get their views.

When I learned more about the international HDTV situation I came to

believe that our program was not just desirable but essential. HDTVs will consume large quantities of semiconductors, as you can see from Attachment 1. The country whose companies supply those semiconductors for HDTV will enjoy a significant economy of scale of production, and will have the massive revenues needed for refining manufacturing and the ever increasing expense of R&D required for developing next generation semiconductor products. In turn, that will give those companies competitive advantage in supplying semiconductors for products other than HDTV, e.g. automobiles and telecommunications, and in fact will give them leverage in gaining market share in those other "down stream" industries.

I received a very interesting report from the Electronics Industry Association of Japan, a Statement on Semiconductors dated 21 November 1988. On page 3 they say "Japanese investment plans [for DRAM production facilities] in the near future have sharply increased. This does not reflect predatory intent but rather a conviction that demand - especially for memory chips - will grow and stabilize with the introduction of new end use products using much larger quantities of DRAMS (such as . . . high definition TV)."

Further, to the extent that HDTVs evolve to be computers, as digital technology inexorably replaces analog technology, an evolution that is inevitable even if its speed is debated, the companies that produce HDTV will have a competitive edge in capturing market share in the computer industry. In all likelihood US firms that are current leaders in the computer industry will play a major role in the HDTV industry. Again the issues are economy of scale and refinement in manufacturing, as well as R&D for product improvement. This is illustrated in Attachment 2.

Referring to that same Japanese report, on page 3 and page 22 they list some of the other end use products that share a common technology base with HDTV, namely laser printers, digital copiers, intelligent work stations, laser fax machines and personal computers. HDTV cannot be separated from office equipment and publishing, to name just two examples.

Before getting into the larger issues I would like to say a few things about the business practices we are following with our high definition display program:

1. None of the work will be classified, although we expect the results to be used in a number of classified programs in DoD.
2. While the result of our work will be subject to the usual U.S. export control regulations, DARPA will seek no additional controls that might cripple US firms in their efforts to export. In particular, if equivalent technology is readily available from non-US sources, then we may be working at odds with bolstering the competitiveness of US industry if we seek to limit exports. In any case our concerns are not with the export of televisions but with the export of manufacturing technology. I hope we can rely on the good sense and proprietary interests of our companies on that score.
3. In order to keep open the opportunity for large scale production, the fundamental technology developed will not be specialized for unique military needs. This would inevitably significantly drive up costs for the military and everybody else. Thus the issue here is not a matter of spin-off -- crumbs from the table -- but rather that we are dealing with the same component technology in the military and civilian sectors.
4. We will assign data rights and patent rights to the companies involved whenever possible and protect their intellectual property rights, so as to motivate them to invest private capital following the initial higher risk Government funding.

In following these four guidelines we are doing exactly the same as we have with our fifth generation Strategic Computer program in parallel high performance supercomputers, software, and artificial intelligence; in neural nets and high temperature superconductors; and with SEMATECH, intended to develop world class semiconductor manufacturing technology. With respect to SEMATECH, I was pleased to see the recent report "SEMATECH 1989: PROGRESS AND PROSPECTS" being prepared by the Department of Commerce, which supports that we are following the business practices outlined above.

5. We have invited interested parties from Department of Commerce, which includes NIST, the FCC, NSF, the Department

of Treasury (Customs), NASA, and other parts of DoD and the Government to work with us on the selection of proposals and subsequent oversight of the effort. My intention is to form an ad hoc group to assist with DARPA's High Definition Display work.

Incidentally, DARPA is not deeply involved in the issue of standards, although we have established ongoing coordination with the FCC so as to synchronize schedules and we have invited them to participate in our proposal selection and subsequent program management as described. We have informally reviewed about a dozen transmission standards that have been proposed, and we are planning to use our unique supercomputer capabilities to support a simulation laboratory for exploring transmission standards. We are currently thinking about ways that those transmission standards can be improved by leveraging off of our technology strengths in areas of image compression algorithms, encryption and software, mostly developed through past Defense investment.

6. What about participation of foreign firms or subsidiaries of foreign firms located in the United States? It may not be possible to have an All-American solution given that certain capabilities like producing certain discrete electronic components may only be available offshore or in US subsidiaries of foreign firms, at least during the near term.

As for foreign subsidiaries of US firms, we will not insist that they be excluded from use of the technology developed by their parent company, although we will discuss the conditions under which that transition will take place.

My job is to work with the bidders, some of which will have foreign connections, to get the best deal I possibly can for the DoD, and that is what I intend to do.

7. Cost sharing by industry is a competitive criterion in our program. This is not a Government bail-out; we are serving an essential catalytic role. DARPA's investment will reduce risk for the bidders, and effectively provide them with some lower

cost capital.

8. We have tried to work very closely with industry associations, like the AEA.

9. We have asked the Defense Manufacturing Board, a distinguished panel of industry experts, to form a working group to advise us on our program.

I'll return to a discussion of DARPA's current program shortly, but first what is DARPA's larger role in all of this? First, for thirty years my Agency has invested to assure that the highest performance technology is in the US Defense industrial base, in areas such as high performance computers, software, artificial intelligence, computer communications like the ARPANET, advanced materials, semiconductor design, lasers and so on.

Second and more recently, we are investing in manufacturing technology in areas where Defense is essentially the only customer, but such a small and unpredictable customer that private industry has been reluctant to invest to develop the production technology needed to raise quality and reduce costs. Examples include high performance infrared focal plane arrays needed for many weapons systems applications and millimeter wave and microwave monolithic integrated circuits (MIMIC) required for such applications as high performance radars.

Third and most germane for HDTV, over the last few years the Defense Department, with DARPA as its primary instrument, has taken the position that National security requires an assured domestic supply of the highest performance and highest quality technology in our industrial base. There are several reasons. One is mobilization. Some reasonable wartime scenarios include a period of increasing tension, and during that period we need a surge capability. Stockpiling of high technology items is impractical because of the rapidity of change in high technology and the variety of items required, and it is impossible to assure alternative sources of foreign supply for any but the most common items. A second and more compelling reason is that the Defense industrial base cannot be separate from the much larger volume commercial and consumer industrial base, a point brought home by the 1987 Defense Science Board Report on Semiconductor Dependency. The economics just don't allow DoD to go its own way, and as the civilian industrial base moves off shore the risk for Defense sharply

increases. In other words, it's hard to separate national security and economic strength. Third and most troublesome, if our military adversaries turn to the companies in foreign countries for their weapons systems technology, perhaps through theft or surreptitious purchase, and if that technology is more advanced or available earlier than in the US, we will be in serious trouble.

DoD can't afford to assure a domestic supply of all technology, and I generally use three criteria in devising an investment strategy. First, we need to concentrate on technologies of the greatest military importance. Secondly, we need to concentrate on technologies that are rapidly improving, so that we suffer a real disadvantage if we get behind even by a few years. And third we must focus on technologies that have leverage for a wide variety of end use products, so as to get the greatest benefit from our investment. Semiconductors, computers, advanced materials and machine tools are clear examples.

DARPA has concentrated heavily in the area of semiconductors, not only with SEMATECH but also through a much broader program of semiconductor production technology, such as excimer laser, e-beam and x-ray lithography. We have always had a major investment in computer and software technology, and are the only Government Agency supporting the major consortium in that domain, the Microelectronics and Computer Technology Corporation (MCC). Our investment in advanced materials is smaller, but notable for its concentration on the manufacturing of high temperature superconductors and support for several consortia forming in that area.

Thus DARPA's investment in high definition displays is a natural outgrowth of past investments and our strategic plan. We have to establish the very best high definition display technology, including manufacturing technology, in the US industrial base. Now I would like to turn to the question of what we will do next.

Where are we and what did US business say they could do, wanted to do, and wanted the Government to do? We have received 82 proposals and 5 white papers. The proposals address not only product technology but manufacturing technology, including special manufacturing equipment, embodied in pilot production lines as well. The proposals address components, like semiconductors and displays, as well high definition

display systems. The components and manufacturing technology are also applicable to intelligent work stations and personal computers, and to an extent other office equipment and publishing equipment. I am struck by three things: 1) The contents of the proposals - product technology and manufacturing technology - is outstanding; 2) US companies, in some cases joined by universities, have formed themselves into strategic teams and formed alliances that did not exist before; and 3) there is tremendous cost sharing by industry. Government funds can serve as a catalyst for emerging technologies and reduce risk, but not be used primarily to bail out industry.

Many of the companies traditionally do not do business with DoD -- we have tried to mobilize a new talent pool. Where defense companies have proposed to play a role they have offered to make use of technology, like signal processing and image compression, from the current defense industrial base. Many of the companies are the innovative small businesses that are America's strength -- but in this case linked to large companies with the know-how to capitalize on invention. There is a strong representation of companies from the computer industry. Two of the proposals were from the Microelectronics and Computer Technology Corporation, or MCC, one of the Nation's leading consortia.

DoD has issued a press release listing the companies and other organizations involved.

We are now reviewing the proposals and opportunities. We will form these teams into a cohesive program, and that will be done very soon. This is routine business practice for DARPA. For example, in the supercomputer part of our Strategic Computing initiative we arranged for a number of computer companies to cooperate in the use of shared chip making facilities that they could not have afforded on their own; to compete in the areas of computer architecture and pricing; and to cooperate in the area of software so that the Mach operating system, our successor to Unix, is now the common standard for nine different types of supercomputers. In the HDTV area I was pleased to see that AT&T and Zenith had joined forces, and we intend to create more such links.

Important value will be added to the enterprise by our integration of the high definition display efforts into the ongoing DARPA technology program. We will make available to the new contractors the very best

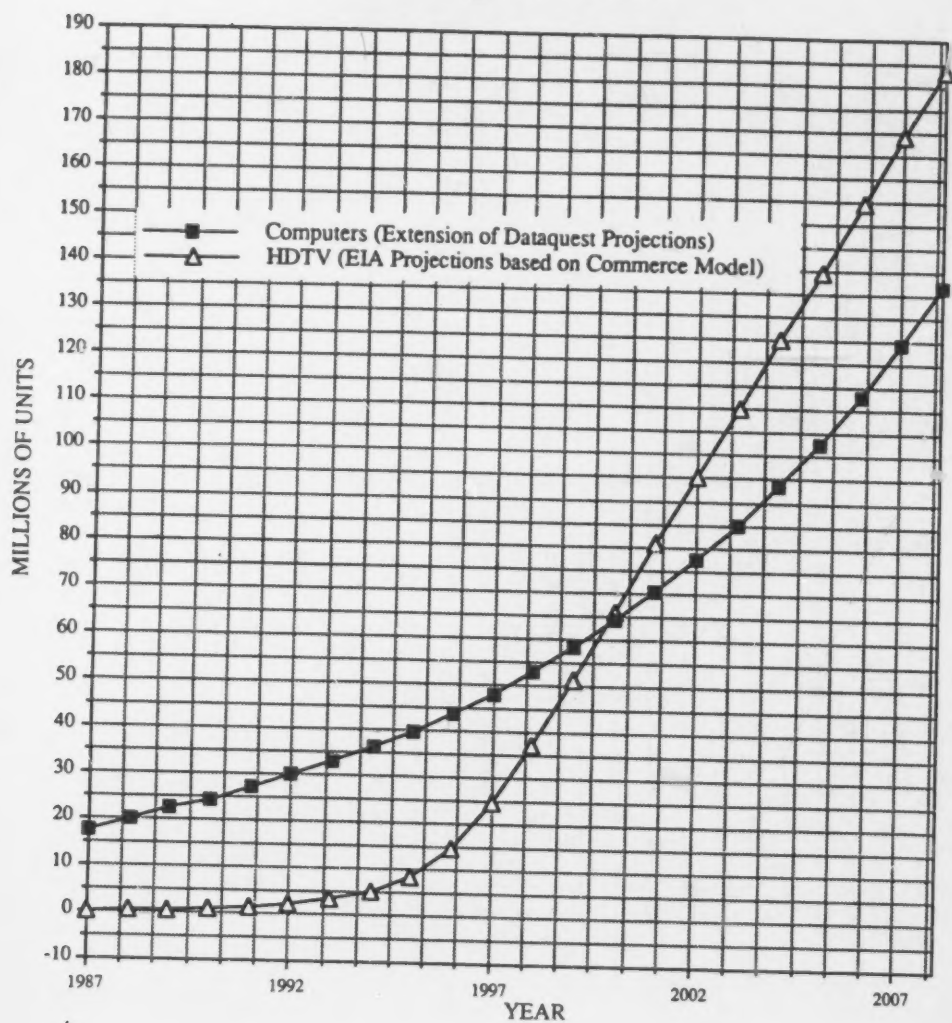
VLSI design tools in the world; unique facilities for rapid prototyping of analog and digital, silicon and compound semiconductor circuits; the highest speed supercomputers for simulation and design; the most advanced algorithms and techniques for image compression and signal processing; CAD tools for dealing with the mechanical aspects of systems, and rapid prototyping capabilities for mechanical parts; to the extent software is involved, the Software Engineering Institute will help in seeing that the most advanced techniques are used for implementation; as optoelectronics are employed, the latest components will be available from our current contractor base; the latest microelectronics packaging technology will be available to the new players; computer-based and in some cases artificial intelligence tools will be available for the manufacturing pilot lines for such tasks as planning and scheduling, as well as for concurrent engineering; the latest microelectronics fabrication techniques will be available through a close link to Sematech; and special circuits and boards for signal processing will be introduced.

Finally, we will identify gaps in our program, and solicit additional proposals to plug those holes.

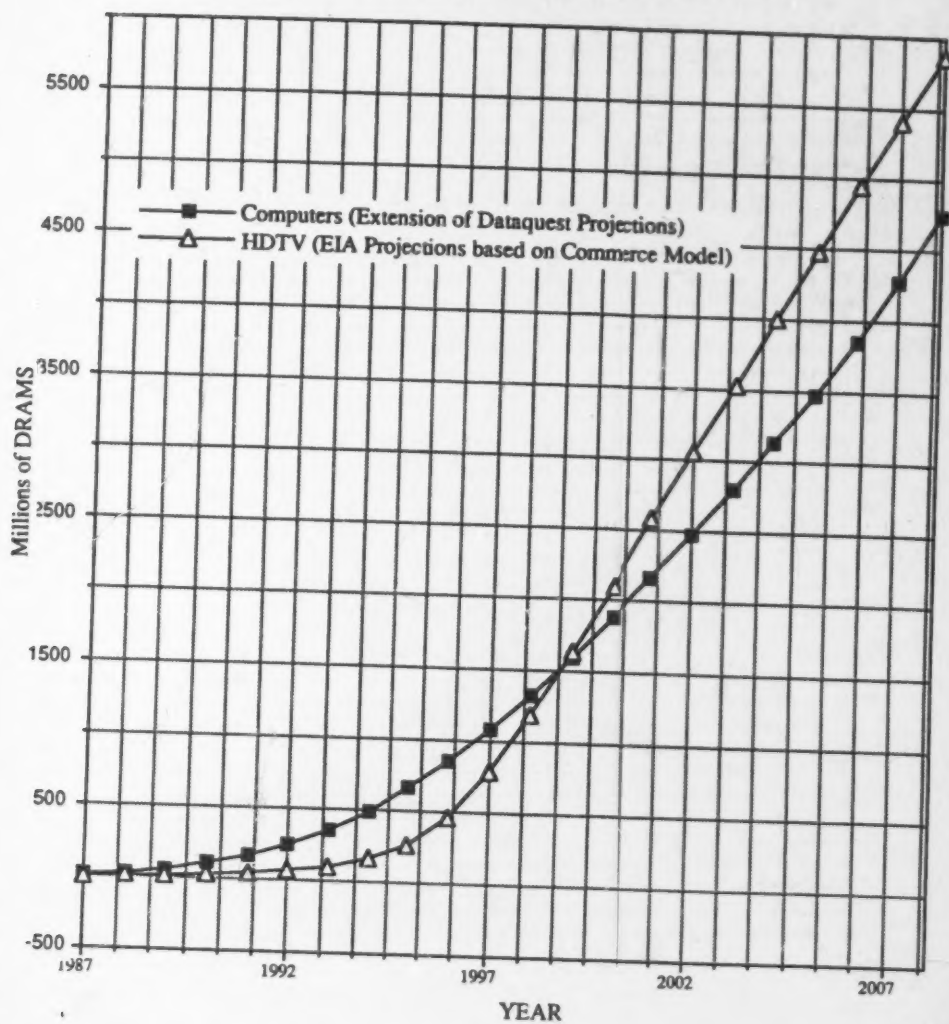
DARPA is essentially unique in the Federal Government in having a staff of technology managers with the experience and track record in initiatives to foster development of new technology products in the US defense industrial base; in forming industrial teams and supporting consortia for DoD; and in supporting a vertical and horizontal defense industrial technology base unmatched by any individual US company.

DARPA took a first small step by starting our high definition display initiative; and, industry has responded with the next natural step of planning and forming teams that can respond to our need. If, as we believe, HDTV is the driver of advanced electronic technology, the US can be back in the driver's seat again if we just show some initiative and spunk -- now. Thank you.

Comparison of World-Wide HDTV and Computer Sales



Comparison of World-Wide DRAM Usage in Computers and HDTV



The CHAIRMAN. Thank you, Dr. Fields. Why don't we hear just for a minute from Dr. Rush—Dr. Rush here—vis. the point of view of some of the ideas that are being pursued by the Department of Commerce. You mentioned that, Mr. Sikes.

Dr. RUSH. Thank you, Mr. Chairman. It is a pleasure to be here this morning with you and your committee. I have been asked to be here by Mr. Sikes to address any technical issues that you may feel require further discussion, particularly with regard to the kinds of production and transmission systems that have been proposed for advanced television.

So I am here at your service. Thank you.

The CHAIRMAN. I think that before we call for questions, what we are trying to get at, and I think Dr. Fields got to it in part, is that we have got to broaden the scope of what we are talking about. The popular perception of the whole debate is that we are looking for a better television picture. And it seems to me that from some of the discussion we had this morning at breakfast and the discussion you both touched upon today—and you, Dr. Fields, have it written in more depth in your testimony—talks about a much broader picture here.

I think that in order for Congress to start to consider—for example, in Mr. Sikes' testimony, you mentioned the point of view that you wanted to be sure that as we pursued this particular area of concern at the moment, that we didn't draw resources from other promising things and technology they're working and the whole bit.

My first logical question is: Which one are you talking about? Because before us is the inevitable battle this time of the year—will there be resources available and how will we allocate them? There are a great many people who are dancing to their own drummer, as it should be in part, and things they believe in to be the priorities of the nation.

We are trying to get across one very fundamental point; that there are not enough resources in the given pot now, no matter what we do in the deficit, both in the trade deficit and in the budget deficit, to provide the resources we need to do all the things that Americans want done and Americans need to be done. And we are saying that's going to persist from here on out unless we do one thing—unless we move to create new wealth. And the way we are going to create new wealth to provide the needs of the country is precisely—this is one of the key areas that you're talking about right now. I think that was aptly put out by both of you.

However, let me point out to you, as the brothers and sisters that are elected to office get together to determine what the priorities will be, we are saying to them if you cut the research and science base in technology and education, you are tearing the bottom, the foundation, out of the new wealth to be created.

And then we have those people come back and say to us, "Too bad. We don't want to spend the money on the Space Station. We don't want to spend the money on the Superconducting Super Collider. They are big-ticket items. We should be diverting our money to smaller uses and other things that are more productive." Then the question is, who determines what is more productive?

So for the Congress, in this member's judgment, to be considering high definition television to be a very important element to the whole economic dynamics of the country, both internally and externally if you like, then we've got to establish that case because it's going to be in competition with everything else we're doing; because every time we have a hearing—you'll pardon me for being so loquacious—we have the same kind of approaches. And I don't mean that disrespectfully in any way.

Therefore, it's very important for the witnesses to tell this committee so this committee can, in my judgment, reflect to the Congress of the United States, this is not just a bigger brighter picture on a television tube. You understand where I'm trying to come from?

Now, that's what we are looking for. Go ahead.

Mr. SIKES. If I could, Mr. Chairman, the report that NTIA released on March 3 dealt extensively with the broader implications. We had the help of Dr. Rush. We had the help of scientists from the National Institute of Standards and Technology, and others. This was truly an intradepartmental effort at the Department of Commerce.

As Dr. Fields noted, we have worked closely with Defense, and some of the material in that report was material that we received from Dr. Fields and others at the Department of Defense. So it was intended to, in a sense, aggregate and therefore talk about the very broad implications.

What I meant to say in my statement is that I think there's a risk of the government getting out in front of the private sector and the government declaring that something is extremely important, putting money behind it in some way, and then stimulating the private sector to allocate resources that they might intend for other more promising developments, simply because of government stimulation.

That's the reason that we feel it's important that we first look to the private sector, and we have done this in very active ways. I mean we've been an active catalyst, and say to the private sector, "Is this something that you are prepared to invest real resources to accomplish? And if you are, then I think the government is willing to enter into a partnership with you."

The CHAIRMAN. Dr. Fields.

Dr. FIELDS. I am not going to comment on issues of priority because that's in your purview, but I do want to comment on an issue of technology.

A lot of people think about a high definition TV as an extremely attractive box for selling the components and technology inside—the semiconductor chips, the displays, CRTs or flat panels, the signal processing chips and so on. It is expected to be an attractive box to lots of people. There will be a large production volume.

The companies that are producing the components and technology in that large production volume that go into HDTV will have an economy of scale production, revenues for R&D, revenues for refining manufacturing, all giving them advantages and selling those components to other things that are not HDTV, like the displays for aircraft, to quote the McDonnell Douglas example.

It is in that context that people think this is a larger issue. It's a driver because of the mass production, but then it gets leveraged with all those other things.

The CHAIRMAN. All right, questions. The gentleman from California, Mr. Brown is recognized.

Mr. BROWN. Mr. Chairman, I'd like to make some comments, but I think I'll skip the questions. Mr. Sikes, speaking particularly to you in the Department of Commerce, I think you know that the members of this committee are not anxious to seize the leadership on this issue away from the Executive Branch. We would prefer to follow a constructive policy strategy and to cooperate with the Executive Branch on this.

So far, we think that you have been moving in the area of trying to understand the implications of this field, but we have not yet developed the strategic policy, and it doesn't have to be one with the government taking over the business or anything like that. It has to be a carefully developed policy following the needs of the private sector, as you have indicated, but one which recognizes the reality of this situation and its impact on the future of this country.

I am disappointed, frankly, that the Department of Commerce, seizing the cues given in the trade bill, for example, has not moved more aggressively—and I understand the reasons for it—we've had a change of administration and other things—but really, during most of last year, we were making this same call for action, that something has to be done, the industry has to get its act together, but the government has to get its act together, too.

I read the preliminary report of your advisory committee. It's rife with analyses of the opportunities but it doesn't come up with any suggested strategies.

I would like to ask you just one question if I can. Do you have in the Department yet, a sense of urgency about this which will lead this to getting the priority attention of the administration in developing that policy that we would like to follow and aid in?

Mr. SIKES. Yes.

Mr. BROWN. The answer is yes. How soon will we know the framework of that policy?

Mr. SIKES. I think that it would be within the next 2-1/2 to 3 months. It is impossible for me to predict precisely. When you and I, Congressman Brown, talked about this toward the end of the last Congress, we certainly agreed as to its importance.

I was part of an administration that was several months from concluding. Secretary Mosbacher has been the Secretary of Commerce for barely two months. I know the competition for his attention and I know that he has put this subject that we're talking about at the very apex of his list. And so I think you can be assured that this has the kind of priority you believe that it should have.

Mr. BROWN. Well, we hope that's the case. You've already heard from both Republicans and Democrats here that we're introducing legislation. We are not that far apart in terms of the framework that we think ought to be done. We've got to do some antitrust things. We've got to do some other things of that sort. We've got to provide that level and type of assistance that private industry needs.

We've introduced these bills because, frankly, we want to let you know—speaking of you as the administration—that we are ready to act, given some guidance. We can tailor those bills to suit the policy needs of the administration and we'd like to do that, but we can't wait forever.

If you think the trade balance is bad now, your projections here about the volume of trade in consumer electronics that we are going to lose if we don't keep abreast of this doesn't give us much hope that we will redress that imbalance in the near future unless, of course, we see continued depreciation of the dollar and all that means in terms of the health of the U.S. economy.

So I urge that on you as strongly as possible; that we try and get the administration to formulate a policy which we in the Congress can cooperate with, in order to achieve our national goals here.

Thank you.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from Pennsylvania, Mr. Walgren.

Mr. WALGREN. Thank you, Mr. Chairman.

I guess one area of—maybe it qualifies under the thought that the horse is somewhat out of the barn, but something we have to be very sensitive to. As I understand it, the semiconductor chip industry was under a lot of pressure from what we have now recognized as foreign dumping and acted against it, and yet there is a real lesson in that, a lesson that might have been learned from other industries that have suffered as directly, like the steel industry and the like, from foreign dumping.

I guess the question is, do we have the will in this area to protect developing American enterprises so that you can have the wealth in the private sector to be able to act as strongly on its own as it can? That question, I guess, is directed to Mr. Sikes, but would we not in retrospect wish that we had been more quick in our protection of the domestic semiconductor industry from foreign dumping?

Mr. SIKES. It is just extremely clear from conversations I've had with Secretary Mosbacher that he understands that export subsidies and sanctuary markets have been not unimportant in what has occurred, and that therefore our administration of the anti-dumping and countervailing duty laws, our work with USTR and others in respect to accessing foreign markets will be a very key part of any sort of HDTV strategy. And I agree with you, it's got to be an important part of our overall effort to remain technologically strong.

Mr. WALGREN. I know there are a number of us who want to encourage you in being especially sensitive in that area. Here we have DARPA essentially saying that their effort is to lower the cost of capital in a sense for some of these efforts.

The reason they have to lower the cost of capital is because the capital isn't there. I gather if there had been financial protection from some of the dumping that has damaged American industry, the capital would already be there and we would see American private sector firms taking steps which now have to be sort of drawn out of them because we have not protected ourselves in the past as we should have.

Let me ask generally, what flesh can you put on the cooperation between the military, as represented by the Defense Advanced Re-

search Program, and the Commerce Department? I guess my fear is that we have traditionally always responded with the military.

The military, to most of us as civilians, is kind of a black box that does what's necessary, and we can in a sense sit back and watch TV because the military is there to do what's necessary. And it was there to do what's necessary in education in the 1950s in the National Defense Education Act. It was there to do what's necessary when we had the gas lines and we responded with the Synthetic Fuels Corporation under a military aegis. It's been there in the computer industry all along. And my concern is that when it's done in that black box of the military, the civilian side doesn't really appreciate what we have to do together.

One of the reasons that the civilian research and development side is so undeveloped and we, when we go to other Members of Congress, they say, "Look, let's cut the National Science Foundation or cut the science effort because we're in the mood of cutting budgets," is because we don't have this developed appreciation of the importance of joint effort in science research, largely because it's been done in this black box in the military by an unseen hand, and done effectively and done well.

But how can we bring that out? How can we bring the cooperation between the Commerce Department and DARPA out so that we all realize that this is a critical joint effort for the country?

Dr. FIELDS. I appreciate the problem that you're grappling with. Al and I and the Under Secretary for Acquisition in Defense, Bob Costello, his deputy Bob McCormack, spent 2-1/2 hours on the 7th of March with the new Secretary of Commerce, Mr. Mosbacher, to try to work out a relationship that we thought was the right one.

There is no question that what we're trying to do is assure for Defense the best possible display technology as well as the underlying components. It is also the case that that exact same technology has civilian commercial consumer application. Physics doesn't know any boundaries between the Defense Department and the Commerce Department, I am happy to say.

The arrangement as I see it is one in which the Commerce Department is taking the government lead. The President has asked the Secretary of Commerce to do that in both formulating and, I believe later, managing a plan to deal with this issue in the United States. What we're doing is supporting that activity by doing that which we think is right for Defense; namely, seeing to it that the technology components of displays and receivers are in U.S. companies and available to Defense, but then again also available outside of Defense.

There are many other issues that are involved, including technology issues of transmission which we aren't dealing with, but a place like NIST can and should, and we are just playing our part in the whole thing.

Mr. WALGREN. Can the Commerce Department respond at all to that area?

Mr. SIKES. Yes. We have, and I don't want to belabor this fact, but we have been working together for a number of months now—it began probably a year ago—there is a Special Projects Office that is being set up that we are actively working together in.

So I think the evidence of cooperation is significant. I might also indicate that there is an analog that perhaps should be pointed out, and that is the Navy helped start the Radio Corporation of America, RCA, back in the late teens, 1918, 1919, along in that area. And, of course, that led to a dramatic improvement in civilian technologies as well.

Mr. WALGREN. I would just like to underscore one sentence in Dr. Fields' testimony that to me is just so important for us to think about and absorb. And it was that the compelling reason for DARPA to be involved in these areas is that the defense industrial base cannot be separated from the much larger volume commercial and consumer industrial base.

If that is true—if that is true—it would seem to me that we ought to look forward to lots of efforts on the part of Commerce to be involved with DARPA and lots of efforts on the part of DARPA to be openly involved with Commerce. And if we could bring that out somehow into the public view, I think that all of us as citizens could appreciate much more how critical the joint effort that we make as government is.

To me, if we had that piece in our public understanding, there would be much more support for doing some of the things that the chairman is so concerned about, as all of us are.

Thank you very much, Mr. Chairman.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from North Carolina, Mr. Valentine.

Mr. VALENTINE. Thank you, Mr. Chairman. If this question has been answered, I apologize. I have not been able to be in here all the time.

I would like to ask Mr. Sikes if he can comment on how the Department of Commerce might be able to utilize the size, the vastness of the American market as leverage to open up opportunities overseas.

Mr. SIKES. I can comment most specifically in the area of telecommunications which is, after all, my principal jurisdictional responsibility. I can tell you that when we began the market access efforts several years ago, we stated specifically that if we were not able to access foreign markets for our telecommunications products, that there would be a reciprocal inability on the part of foreign companies to access this market. That, of course, became law in the telecommunications trade provisions of the Omnibus Trade and Competitiveness Act.

I can tell you that as a result of that leverage, the importance of people assigned to needing to continue to access the United States' telecommunications market, that significant strides are being made to open overseas markets for U.S. telecommunications products. So that I think the point you make is a good one.

Mr. VALENTINE. One more comment or question, Mr. Chairman, if I may. I realize that this is a new team, a new administration, and I don't have information on which to base a valid judgment about what I am going to say. But I just want to stress to you that the perception is that our trading partners overseas continue to laugh at us; that they have access to this vast American market and we fall into all the little traps that they provide for us which makes for an unfairer situation still.

I hope that this will be a major objective and aim of your Department in the years ahead, to try to really make not only some changes that are real, but to change the perception so that we won't have to continue to operate from what appears still to be an unfair situation.

Thank you.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from New Jersey, Mr. Torricelli.

Mr. TORRICELLI. Thank you, Mr. Chairman.

Mr. Sikes, you expressed a deep fear of the government getting out front on this issue. You say clearly, "Some of us call that leadership. The government getting out front is exactly what is required. If indeed the economic health and security of this nation depends upon success in this endeavor because of the related and dependent industries, it cannot rest upon the collective judgments of a few private individuals who may or may not seek profit and see opportunity. There is something much more important at issue."

It is not a question of the government stifling private initiative. It is the government's making clear what the stakes are, the terms of the investments, the scale of the opportunities. That's leadership.

I don't know what your report is going to contain. Because this is a new administration, you certainly cannot be held solely responsible. But this would have been a very timely issue in the 1970s. This would have been an opportune chance for us to plan a program in the 1980s. You are already late before the report is even issued.

That increases the scale of what it is that must be included in that report. It must deal with a magnitude of an issue, a scale of investment that wouldn't have been contemplated 10 years ago. But now nothing else deserves to be written, and I hope that is understood.

My question to you clearly is that the report that I am looking for, the one that I hope to receive and hope to join you in supporting, will be along the scale of that written by Mr. Ritter in his own legislation; that it will deal with antitrust questions; that it will deal with broad funding to the tune of not \$30 million in DARPA, but \$100 million, up front, with long-term financing; that it guarantees, as Mr. Ritter would provide, a government source of clear purchase; that a market is provided immediately; and that it will deal finally with the protection as well of a domestic market to make clear to those private entrepreneurs, for which you state such concern, that if they make this investment, that it's not going to be wiped out and away from under their feet, as we have allowed to happen to the remainder of the electronics industry, from dumping.

My question to you then, sir, is: Is this the scale at which you are going to make a proposal? Is it going to be this comprehensive? Are you going to deal with each of these issues?

Mr. SIKES. Let me say initially that the government has taken the leadership position. Now, I can't comment about the 1970s. I wasn't here in the 1970s. But I know that three years ago, at the National Telecommunications and Information Administration, we began to call together industry leaders. Two years ago we held our

first day-long session with industry leaders. Well over a year ago, we issued what was the Darby Report, prepared by an economist that we hired to take a look at the markets, the potential economic impacts, the technological implications.

We convened a series of agencies within the government, both within the Department and across departmental lines, to investigate this subject more substantially. We have been an aggressive catalyst, believing that we could point to the implications, that we could point to the scope of the potential problems but that, after all in the final analysis, we didn't have any vice presidents of marketing, of distribution, of finance, and a range of other talents that are necessary when you decide how you are going to allocate market resources.

For example, yesterday in the Wall Street Journal, there was an article about the fact that IBM said that its researchers are working on a prototype color flat panel computer display that is larger and clearer than any demonstrated so far. That was done at IBM's behest, not at the government behest.

So I first of all don't think we should disregard, that we should somehow depreciate the quality of our U.S. companies, the substance of the technology—

Mr. TORRICELLI. Mr. Sikes, I'm not taking issue with American companies. I'm taking issue with the American government. I have every respect for their abilities to produce.

If the Chairman would allow me a moment to conclude.

Government is taking a lead. The problem is, it isn't our government. At the moment, we are here discussing the outlines of a proposal you will make at some point in the future. The Japanese today are involved in testing an experimental broadcast, not under the leadership of some private entrepreneur in Japan, but under the leadership of the Japanese Government.

Permit me to say that if Woodrow Wilson had had this view of government waiting for industry to take a lead before he defended the American interest, there would have been no RCA and no American leadership in radio. And if Franklin Delano Roosevelt had had the same view, there would have been no American leadership in the aircraft industry when he took leadership and provided subsidies.

This isn't the responsibility of the Zenith Corporation, While I respect the leadership they have taken to do so; this is your responsibility. I hope that what you are doing when you begin to write your report is you take Mr. Ritter's and Mr. Levine's legislation and begin there. That is the scale of what is required.

Finally, Mr. Chairman, in my conclusion if I could just leave a thought with Dr. Fields. I have not asked you whether or not in reviewing spending your own relatively insignificant and inadequate funds—in my judgment—in your program, you are going to consider all those proposals that have come from foreign corporations as well. I haven't asked you that because I think it's insulting to even suggest.

I am operating under the assumption that those proposals that we reviewed seriously are those that have come from American companies and that the American taxpayers' money will be used to

fund this research, knowing that the end results will remain on shore.

If you do not answer the question, I will assume the proper answer.

[Laughter.]

Mr. SIKES. Let me just say, in reaction to the second part of your question, Congressman, that the material embedded in legislative activity by Representative Ritter, Representative Brown, Representatives Boucher and Campbell in the antitrust area, just to name a few, are all options that are on the table currently and are being considered in the policy development area.

The CHAIRMAN. Did you want to respond, Dr. Fields, or with your silence was it understood that there aren't any foreign consortiums you are planning on funding with that \$30 million? We would like to know that.

Dr. FIELDS. We can proceed.

The CHAIRMAN. Pardon?

Dr. FIELDS. We can just proceed.

The CHAIRMAN. Okay.

[Laughter.]

The CHAIRMAN. The Chair recognizes the distinguished gentleman from Pennsylvania, Mr. Ritter, and he welcomes him back again.

Mr. RITTER. Thank you, Mr. Chairman. And I might make an announcement. There has been an historic election in the Republic Party, and probably that Republican Party will never be the same again. Newton Gingrich has been elected whip, and it's going to be very interesting around here in the next few years.

You could say for better or for worse. I would like to think it's for better. Some of my colleagues may think otherwise, however.

I would like to ask the panel—it has been claimed that the U.S. computer industry, with strengths in digital and advanced microprocessors, advanced telecommunications industry, and advanced electronics, on its own could take the tack of a digital approach to high definition television which would obviate the necessity for a private/public partnership or a grand design government strategy.

What would your thoughts be on that? By the way, I might add that George Gilder is debating Richard Elkus in S-207 at 12 o'clock. It should be fun because I think this question is going to come up.

Mr. Sikes, do you want to respond to that?

Mr. SIKES. I can say that the perception I have is that we should not despair based on a belief that the United States is behind significantly; that the industries and technologies that your question implicated are reason for some optimism.

I know that Dr. Fields, who reported while you were gone on the proposals received by DARPA, has reason for some optimism. I also know that a strategy of catching up is generally bad business strategy, and so I would concur with the essential point that was made in your question. But I would like to defer to Dr. Fields on the more technical aspects of your question.

Dr. FIELDS. Actually, you asked three questions as I heard it: one about the computer industry, one about digital technology, and one about having a strategy. I want to separate those.

I don't see any way to succeed without a plan and a strategy and that's exactly what Mr. Sikes and the Commerce Department are going to do the next few months, as has been pointed out in the discussion.

Number two, regarding digital technology, that is an important contributor to this. I am a big fan of digital technology since we support so much computer research at DARPA. But one of the dangers that we have to avoid is looking so far out into the future that we never get there. So that is something we are mindful of in our particular tactics in our investment.

Thirdly, the computer industry isn't going to do this all by itself. In fact, I had a discussion with one of the CEOs of a very large computer company who feared submitting a proposal to DARPA because of his belief that that would send an incorrect signal that they were going to save the day all by themselves. That is not the case for any one company or for any industry of that nature. It is really broader than all of that.

Mr. RITTER. Then we are in agreement that a comprehensive approach is essential here. I take it that this is what the Economic Policy Council in the White House is working on currently. Is that correct, Mr. Sikes?

Mr. SIKES. Yes, that is correct.

Mr. RITTER. And so if we talk about a comprehensive approach, are we also talking about the strategy to nurture an infant industry? Are we talking conceivably about developing trade policy that conceivably could even take a page from the book of our competitors to deal with this issue comprehensively?

I know this is the Science and Technology Committee but I am struck by the interdependence of what we do across committee boundaries and across government agencies here. It is absolutely essential that this be an integrated approach.

Would this include conceivably, as our bill says, to approach trade policy to set an appropriate environment for an infant industry?

Mr. SIKES. I can answer by saying that I think aggressive use should be made of existing trade laws. I believe existing trade laws are adequate, and I think it is because of the recognition of the fact that we are in a global marketplace that we can anticipate changes in antitrust laws which would allow combinations of companies that under current laws might not be able to get together.

Mr. RITTER. One last question. The production standard strategy of the State Department and of the government was set at a time when we really were not in that game. I guess you could put it that simply.

Have any feelings changed, shifted, on the U.S. position on the 1125/60 production standard, or do we feel that the production standard and the transmission standard are sufficiently separable so as to not feel impeded by the acceptance of someone else's production standard?

Mr. SIKES. NTIA approximately a half year ago decided that the issue of our advocacy of 1125/60, before the International Telecommunications Union's Consultative Committee on International Radio (CCIR), should be revisited. We, as a consequence, issued a Notice of Inquiry. There were 40 companies or academic institu-

tions or organizations that commented in that Notice of Inquiry. Approximately two-thirds of those who filed comments believed that we should either not continue to support a single standard or that we should not support the 1125/60 standard. Approximately a third believed that we should continue.

There will be, as a part of this overall policy review, a specific decision on whether we will continue as we have in the past, supporting 1125/60. And you probably are aware that the most crucial meeting in that respect will be held in May of 1990, the Plenary Assembly of the CCIR.

Mr. RITTER. Mr. Chairman, I yield back. I want to thank our witnesses both for really leading the charge in terms of their respective agencies to help bring this issue to the forefront in the administration.

Thank you.

The CHAIRMAN. I thank the gentleman from Pennsylvania.

The Chair recognizes the distinguished gentleman from Illinois, Mr. Costello.

Mr. COSTELLO. Mr. Sikes, I am wondering, given the size of our domestic market, it would seem to me that the Department of Commerce could use that domestic market as leverage to open up a business that is now closed to us. I wonder if you might comment as to what the Department is doing in that regard.

Mr. SIKES. I would be going a bit far afield if I got beyond communications products in the area of international trade. As I know you are aware, Mr. Costello, we have an International Trade Administration and they rather prefer that I not come up and talk about trade policy and the implementation of trade policy.

I do know that in talking to Secretary Mosbacher, he has been quite aggressive in respect to the use of existing trade laws and the use of the sizable homogeneous market here in the United States and the fact that a number of foreign companies enjoy and indeed depend on access to this market and to use that combination in making certain that U.S. companies are not in any sectors disadvantaged in accessing particularly the developed markets of the world.

Mr. COSTELLO. Did I understand you correctly in your testimony that about 40 percent of consumer electronic demands come from this country? Is that correct?

Mr. SIKES. That is correct.

Mr. COSTELLO. Thank you. I yield back the balance of my time.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from Tennessee, Mr. Tanner.

Mr. TANNER. Thank you, Mr. Chairman. I have one question for Dr. Fields if I might.

You indicated, sir, that national security would require an adequate domestic supply of the highest technology and so forth in this area. If we do not move ahead, do you perceive this to be a national security risk and threat and, if so, what would your comment be to that risk?

Dr. FIELDS. There is no way for me to quantify the risk of being unable to buy critical components for weapons systems, as I am sure you appreciate.

The Department took the position that the semiconductor industry was important for national security. We support it through direct R&D. We support it through SEMATECH. And some of the components are being supported through this particular program we have discussed this morning, and it is just very important for us to have.

Mr. TANNER. The reason I asked that question, Mr. Chairman, is Mr. Brown's comments that led off this discussion. I don't see a sense of urgency that he alluded to in this entire spectrum from the Department and perhaps we need to go further in this regard.

The CHAIRMAN. I thank the gentleman from Tennessee.

The Chair recognizes the distinguished gentleman from California, Mr. Mineta. Norman Mineta from California.

Mr. MINETA. Thank you, Mr. Chairman.

Frankly, I am really disappointed, in fact I'm seething just sitting here listening to this panel. I happen to be a very proud member of this House of Representatives. I also happen to be of Japanese ancestry, and people sometimes ask me, when the rubber has to meet the pavement, which side I'm on. It's that insulting.

I'm going to ask you that same question. What side are you on? I mean you use the right words: comprehensive approach, significant, policy reviews. We don't want any sector being disadvantaged.

And then, in light of what you are saying here, the government ought not to be out front ahead of the private sector. In view of the Department of Commerce's stand on FSX, I wonder where we are. Can you give me an answer in terms of leadership on this issue?

I think Mr. Torricelli was absolutely correct. I think the line that Mr. Ritter is taking in terms of his bill—and I know at this point you can't comment on the bills that are before us—but I'm just really wondering, is the Department of Commerce going to exert some kind of leadership on this effort? And don't give me just a yes.

Mr. SIKES. I would suggest to you that there were no congressional hearings being held two-plus years ago when we started leadership on this project.

Mr. MINETA. You're right; the hearings have not been there. But the issue has been coming down the pike quite a while. The issue has been here quite a while.

Mr. SIKES. I think that again there perhaps is simply a philosophical difference. I believe that we have been in a leadership role. I think we have been an aggressive catalyst. I don't know what more I can say than I have said.

Mr. MINETA. No. But I get the feeling—

Mr. SIKES. I think that the private sector—

Mr. MINETA. Mr. Secretary, if I might. I get the feeling that you want the marketplace to make the determination as to what is going to happen, and you will let this thing slide along enough that the private sector will make decisions without any precipitous action on the part of the government, and you will be in the position to say, "See, the marketplace did the right thing. We didn't have to pick winners and losers."

But it seems to me time is working against us. And then on top of that, when I see that Sony is going to be part of the applications

that are going to be accepted at DARPA in terms of the applications for research, then it seems to me—and maybe I could get a clarification on this from Dr. Fields—but I have an article saying that the Department of Defense has accepted Sony Corporation of America's application for its high definition television project.

Maybe you could correct me on that, Dr. Fields.

Mr. SIKES. I would just like to say that again we can differ on the extent to which the government should or should not have acted in the past, but I think the steps that have been taken by both the Department of Commerce and DARPA—Dr. Fields outlined the 82 proposals that have been received, the significant amount of teaming that has resulted have been leadership steps.

Mr. MINETA. Then let me ask, Dr. Fields, am I wrong in reading this article about the Pentagon accepting Sony of America's application?

Dr. FIELDS. Well, you're not wrong. It depends on the word "accept." If you mean accepted in our mail room, that's exactly correct. The fact is we received proposals from Phillips, from ITT—this was all in a press release we put out—subcontract proposals from Thompson, as well as two proposals from Sony.

And as I outlined a couple of weeks ago, we have approached all of these proposals with a view toward establishing a benefit for the United States, looking at where R&D was going to be done, where R&D licensing was going to be done, where production would be done, where components would be purchased, and where the revenues from all of this would be plowed back.

In a government-only meeting, I would be perfectly happy to tell you exactly where we are, and I think you would be satisfied that we have done the right thing.

Mr. MINETA. All right. Then maybe I'll wait to hear further on that. But I just get the feeling that they are included because we are afraid of some kind of retaliatory action that might be taken by our trading partners; or, secondly, that we want to get some of the technology that they have already developed.

Frankly, having dealt in this whole area of trade for a long period of time, coming from Silicon Valley, dealing with the semiconductor issue, it started with the International Trade Commission in 1976, and I've seen this thing just getting frittered away. And I see another opportunity possibly being in the same position.

It just frustrates me to see what's happening because it's like *deja vu*; it's like watching your Cadillac going over the cliff with your mother-in-law in the thing.

[Laughter.]

The CHAIRMAN. Did you want to rephrase that again, Mr. Mineta?

[Laughter.]

Mr. MINETA. I will revise and extend my remarks, Mr. Chairman.

Dr. FIELDS. I want to absolutely assure you that there was no component in our mail room receiving and reading proposals from Sony or any other firms that were political or concerned with retaliation or anything like that. They just have a right to do it.

You should realize that the same questions that I listed earlier—where is R&D going to be done, where is production going to be

done and so on—have to be asked of the so-called American proposals, because if R&D labs of American companies are in Japan or in Switzerland, if production is done in foreign countries, well that's an issue there, too.

That's why we are going into each case on an individual basis. Again, in an government-only meeting, we can have a much more substantive discussion.

Mr. MINETA. I appreciate the panel. I don't mean to shoot the messengers, but I just get very, very angry sometimes as I deal with these issues and I thank the panel and thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentleman from California.

The Chair recognizes the distinguished gentleman from New York, Mr. Scheuer.

Mr. SCHEUER. Mr. Mineta expresses a frustration and an anger compounded by frustration that we all feel. But looking at it rationally, we complain on the one hand that we are giving FSX technology to Japan at very little price. We don't want to share our technology that would enable them to sort of wipe us out of the whole aircraft industry sector. But then we object to inviting the Japanese to come over here.

Sony, which is probably the most prominent electronics firm in the world, with probably the most in-depth research capability, we object to their coming over here and sharing their technology with us. It seems to me there is a logical inconsistency there.

The question is, how do we collaborate with them on FSX and not cripple our own industry in a fatal way, and how do we invite Sony to come over here and collaborate with us in a way that's fair to them but in a way that will give us some advantages of their advanced technology, too?

These are all difficult questions, and since tempers are on edge here, there have to be rational answers. Let me say that if we really have an integrated approach, we have to go far beyond the specifics that we have talked about this morning.

One of you mentioned this morning that if we look too far ahead, we'll never get there. Believe me, that has never been the problem in this country. The problem in our country is, by golly, we don't look far enough ahead. We are preoccupied with the bottom line, not only the annual report, but the bottom line in this current quarter report. That's what the security analysts look to.

And if industry can't learn how to plan five, 10, 15, years ahead, we will never get there. We don't look too far ahead. Our problem is not looking far enough ahead. Looking far ahead, there are some things that government can do and I hope they will be included in your overall plan.

We can do more to encourage savings in our country. We have a 3 or 4 percent savings rate; the Japanese have 18 or 19 percent. That's why they're so preeminent, because they have tightened their belts and they've saved capital and they invest it in long-term goals and long-term research that won't pay off for a decade or two.

So government ought to facilitate and encourage and provide incentives for savings, a vastly higher rate of savings, and industry

ought to begin thinking about a viewpoint of a decade out front, rather than the annual report and the quarterly report.

Second, in the area of science education, now about a half of all graduate students in this country studying science, math and engineering are foreign students. Now, none of us are xenophobic about foreign students, but as a practical matter, they come here, they do sop up a lot of knowledge, and they do go back to their own countries. Maybe that's as it should be.

But certainly we ought to be doing everything we can to make sure that any American kid with talent to be developed in science, math, and engineering has a chance to go to a good high school, a good university, a good graduate school, and finally a National Science Foundation postgraduate fellowship. We ought to be doing far more than we're doing now to afford every talented kid in this country a chance to go to the limit in science, math, and engineering, and our long-term future is just as much tied up with a broadly-based science education for our academic and talented elite, to make sure that every one of those kids gets the chance to go that extra mile, as it is in the kind of limitations that we're talking about, trading access to our market for opening up the Japanese market.

I don't say that isn't true, but there are a heck of a lot of other things we can do to enhance our long-term competitiveness and improve behavior, both government and business, to increase our savings rate, increase investment in high technology, and a vastly increased access to all levels of science, math and engineering to every American kid is part of our long-term future, part of the urgent demands if we are going to be a viable, competitive player in global commerce.

Thank you, Mr. Chairman.

The CHAIRMAN. I thank the distinguished gentleman from New York. The Chair recognizes the distinguished gentleman from Texas, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman.

I think I want to maybe extend the questions that the gentleman from Tennessee propounded a few moments ago security, national security. I think this meeting certainly serves the purpose to nail down the fact that we're facing the usual dilemma: should government move ahead; who is going to do what; and when are they going to do it?

I think Chairman Roe certainly hit the nail on the head when he pointed out that we may become just a nation of assemblers. That's just something in this thrust that we cannot afford.

When we talk about national security, particularly it's an economic national security I think the gentleman from Tennessee inquired about a few moments ago, our leaders seem to be interested in national security and particularly in energy security, on energy policy, till the polls close. Then we go back to that same old 4:1 ratio with the 10 states that produce energy being outvoted by the 40 states that use the energy.

Now, we are getting that same treatment worldwide. Certainly Chairman Walgren hit the nail on the head also when he said all too often in recent years, a familiar pattern has appeared. Ameri-

can science and technology performs the research and invents the machine, and then foreign companies capture the market.

I was in the aluminum business, and the technical assistance agreements with the Japanese was our major push. I'm not a Japanese-basher; I'm a Japanese admirer. I think they have one of the strongest, greatest economies in the world, and we might tear a page out of their book. But they would buy a window from us or a patio door and improve on it before they went back to the airport. And it is that that we are going to suffer right here.

Along the line of economic national security, I would like to know, Dr. Fields, what is the current state of our consumer electronics industry? Can we just wait for hearing after hearing after hearing? And I'm not saying that critically because I think you folks were out ahead of the market perhaps a couple of years ago. But what do we need to do? And how can we follow up on this and support Chairman Roe in setting this hearing and getting this kicked off?

Dr. FIELDS. I would like to defer on questions of the consumer electronics industry to Mr. Sikes if you wouldn't mind. I would be pleased to deal with DoD issues.

Mr. HALL. You were the closest to me.

[Laughter.]

Dr. FIELDS. Yes, I understand that.

Mr. SIKES. You know, that's an instance of deference without rationale. I think what you've got to do is look at the parts of the consumer electronics industry. Are we in strong shape in television, in any sort of depth assessment? No. That is not to in any way slight a very good company in Zenith.

Are we in strong shape in personal computers which many believe are now part of the consumer electronics market? Yes.

Are we in strong shape in cellular telephones which many are now putting in the consumer electronics market? Yes.

So I don't think it is as easy as just simply saying we are moribund, as some have suggested, in the consumer electronics market. I think there are certain product lines, and I think the ones that we are talking about—the television and the VCR lines—are ones where we have perhaps the least deployed assets.

Mr. HALL. You know, out in the field we get asked questions that are so far down the road from this hearing that I don't even have an answer for them. But people read just enough about this to wonder whether they're going to be able to wear out a television set if they buy it next week before this pushes it off the market.

As chairman of the International Scientific Cooperation Subcommittee, I think with guidance from Chairman Roe, we are going to look into further hearings in this area and concentrate probably on international standards, the need for production and transmission standards, and the pros and cons of some competing systems that are being proposed as standards. We certainly will be looking to your leadership and your guidance, and reading this record. I have missed a lot of it. I had to be at another hearing, but I certainly appreciate your time and support.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from Colorado, Mr. Skaggs.

Mr. SKAGGS. Thank you, Mr. Chairman.

It is my understanding that the Advanced Technology Program at the National Institute of Standards and Technology has, or ought to have, a role to play in our efforts in this area, particularly I would assume as it pertains to the development of standards that will apply, and this to some degree is follow-up on Mr. Hall's point.

Could you comment on that? What is going on at NIST in this area? What are your plans?

Mr. SIKES. First of all, as I mentioned to Congressman Brown, who has an enlarged role for NIST in his legislation, that will be something that will be considered in the policy review.

Relating to standards, I guess maybe with some pride, I am going to begin by saying the National Telecommunications and Information Administration has been the principal organization responsible for standards in this area, and we have worked through our Institute for Telecommunication Sciences in Boulder.

We have programs today with respect to, for example, assessing the use of augmentation channels to provide high definition television terrestrially in the United States. But we also work closely with NIST in international standards processes and in areas where they have substantive competence as well as we have substantive competence. And this is an area where we will be working with them.

Mr. SKAGGS. I assume that there is also research and development work going on within the NIST laboratories in support of the standards efforts. Where is that work located? How is that being funded?

Mr. SIKES. I talked yesterday evening, and I really would suggest an active exploration with the gentleman I talked to, Congressman, Ray Kammer, the Acting Director of NIST. He indicated that the areas where they are working with some intersection in what we're talking about deal with open system interconnection, optical electronics, and that this area that we are talking about, while related, is not primary in any research they are doing currently.

Mr. SKAGGS. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Packard from California.

Mr. PACKARD. Thank you, Mr. Chairman.

Mr. Sikes, you have been chairing the working group and, I am sure, working toward your recommendations. When will those recommendations be available? What is your plan?

Mr. SIKES. I think it's important to note where I am and where I am not. I chaired the Working Group in President Reagan's Administration. Our responsibility was to determine the scope of the problem, the implications. We did that, and the reports have been released. I will not be chairing the working group in the Bush Administration. The Department of Commerce will, however, institutionally be chairing the working group.

I talked last night with the counselor to Secretary Mosbacher, Wayne Berman, and he indicates that it is proceeding and that he would hope to have, within approximately three months, the results of that policy process.

Mr. PACKARD. Thank you very much.

DARPA, as you have mentioned and we've known, has been given \$30 million to conduct research in the HDTV area. Would

you respond to what is planned in terms of converting that research technology into the private sector?

Mr. SIKES. If you don't mind, I'd like to defer to Dr. Fields to answer that question.

Mr. PACKARD. Please, Doctor.

Dr. FIELDS. First, it is worth noting that the funds that we're applying in high definition displays, the underlying components and technology are part of an ongoing effort we've had for many, many years in man/machine interaction, in displays and display technology. So this is a very long-term effort and it is not explicitly targeted uniquely at high definition television as a consumer product, but it's the underlying technologies and components.

It turns out that they are as far as we can tell the same, be they aimed at military uses or aimed at consumer civilian commercial uses. So to the extent that U.S. firms are prepared to and able to sell that technology, the services will buy it in order to put into systems and others can buy it as well. That's the way we're looking at it.

Mr. PACKARD. That brings up the next question, then. That is, what is your evaluation, Mr. Sikes, perhaps as to what kind of excitement we have in the private sector on HDTV? Is it sufficient there to pursue technology that might be developed through DARPA's grant or other government efforts?

Mr. SIKES. I don't think the evidence on that is empirical. My opinion is that there is a great deal of interest. I think it's on both a cosmetic and a substantive level. I think you're probably aware of the efforts the Secretary of Commerce who has called together some key companies and has spoken to them. And we know that many of those companies are now involved at the chairman level, and I underscore that, in talking about ventures together.

The American Electronics Association has announced recently the formation of a group of I think 30, approximately, companies that are funding the Boston Consulting Group with regard to business plans. Dr. Fields has spoken of teaming that's going on in respect to the DARPA procurement. AT&T and Zenith announced that it is their intention not just to work on the underlying technologies but to also work on the end user product, the television set.

I think another way to look at this, and something that gives me reason for more optimism is that we're talking about a television set in the future which at the very least internally is like a computer. And we're talking about a U.S. computer industry which controls a significant amount of the worldwide demand for the high resolution displays that go along with their computer systems.

So, to the extent that we're talking about similar products, and I think we are, whether it's television sets, monitors, work stations, then I think we can see the demand for the ultimate product being quite significant in the United States.

Mr. PACKARD. I think that's the thrust of my concern and, question is what are we doing and what can be done to excite the private sector, recognizing that not only are we looking at the television industry of the future, but we very well could be looking at the computer industry of the future and, of course, American tech-

nology has dominated that area, and we could be at risk. If we lose the one, we may lose the other. And that, I guess, is the concern.

But you see the coalitions now developing in the private sector that will move this forward from a private point of view, and that perhaps will be the basic thrust rather than a private/public sector coalition.

Mr. SIKES. I do see the coalitions forming. I do think that there is going to be some government involvement so that there will be a partnership in some respects. I also think that hearings like this have been extremely valuable in stimulating that private sector interest and in helping concentrate the leadership on what this means.

The CHAIRMAN. The gentleman from California, Mr. Campbell, is recognized.

Mr. CAMPBELL. Thank you, Mr. Chairman.

Secretary Sikes, I applaud your being here and I do think in view of some of the earlier colloquy in which you've been involved, that you should know that there are those who share your view that private enterprise offers a very hopeful opportunity and that new technology does not necessarily require massive amounts of federal government intervention.

So keep up the good work. I think your theory and practice are both right on target.

I would like to ask you one question, if I may, dealing with precisely how we can allow private industry better to cooperate. You were kind enough to mention Boucher-Campbell in an earlier answer to a question, and so I would like to direct my question to that topic.

The National Cooperative Research Act of 1984, as you know, Mr. Secretary, limits antitrust immunity to research and development and does not permit consortia to go farther into manufacturing and commercialization.

In addition, that bill only de-trebles, it does not eliminate the prospect of being enjoined once you have commenced a major project, one that has high fixed capital costs.

My concern was that in an area like high definition TV, if United States are going to make a major entry, they will need to sink specific capital cost, not recoverable in another use, so that the threat of injunction or single damages would be every bit as devastating as the old treble damages.

And the other concern was, as I expressed at the start, the present law does not allow an antitrust exemption once you go beyond basic research and development.

That is how I view the situation and that is why I, in a bipartisan effort with my colleague from Virginia, introduced the bill H.R. 1024.

I would like you if you could, please, to comment on whether you believe a mechanism established in such a bill would be of significant use to the American industry in high definition TV.

Mr. SIKES. Yes. I think that it would be. The administration has welcomed, as I know you and Representative Boucher know, the initiative that the two of you have taken, believing that the legislation is an important contribution. It is continuing—I'm speaking now of the administration—to review what kind of alterations it is

going to support in our antitrust laws. Its fundamental beliefs are that in a global economy with high technology demanding such extraordinary research and development costs, with product life cycles being shortened significantly, that alterations are necessary in order for us to be competitive.

And so I think again the contribution made by the legislation is quite significant.

Mr. CAMPBELL. Thank you, Mr. Chairman. I yield back.

The CHAIRMAN. The Chair recognizes the distinguished gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Just to follow through on what Congressman Campbell has been talking about here, there are government impediments to our business, are there not—to our business competing with the Japanese in this area?

Mr. SIKES. Yes. There are varying points of view on this, and I think that—and I don't mean to transfer the burden of responding to your question to Mr. Pearlman, who is the Chairman of Zenith, is here, will be on the second panel. But I do think it is important you get a private sector point of view on this.

You know, we do not have a U.S. company in the top 10 consumer electronics companies in the world. Now, given that fact, what kind of teaming would be illegal? And many different views have been expressed on that. Some views are that a considerable amount of teaming, of venturing, combining, can occur; and that additionally they can go after these markets on a very vertical basis, being involved not just in research and development, as Representative Campbell noted, but beyond that in production, perhaps in marketing, distribution.

I am not a specialist in this area so I don't want to respond absolutely that there are barriers, but clearly to the extent that there are barriers, we think they should be removed.

Mr. ROHRABACHER. Well, let me ask you to give me an analysis, then. You are someone who has been around Washington here, and you know about this technology. Is the fact that we are behind on high resolution television, or high definition television—you can also call it high resolution television as well, I guess—does this reflect an absence of government leadership, or does it reflect the fact that we have government roadblocks in the way of the private sector developing and applying this new technology?

Where would you put most of the blame if you had to say it's 60 percent on one side and 40 on the other?

Mr. SIKES. I think that television didn't change for a number of decades. Producing television sets became a process of producing commodities. Increasingly, other countries and companies got involved in television. It moved the margins down to razor-thin levels. Many U.S. electronics companies that previously were in television saw better profit margins in other lines and they began to get out.

There were companies that were given sanctuary protection in their home markets and therefore made super profits in their home markets that essentially subsidized their exports.

So I think if you take all those things together, you probably have the reason that we are not a significant—well, you probably

have the reason that we are less than strong in video consumer electronics today.

Mr. ROHRABACHER. But you're not taking the position that the only reason the Japanese seem to be moving so far ahead of us in this technology is simply because the government hasn't taken the leadership of the private sector on this?

Mr. SIKES. No.

Mr. ROHRABACHER. All right.

How far ahead of us do you think the Japanese are in HDTV? I was absent here, We elected a new whip for our party, so I'm sorry I wasn't here. But how far ahead are they?

Mr. SIKES. I don't know.

Mr. ROHRABACHER. You don't know. But you did say that we are ahead in terms of personal computers and in terms of many computer technologies. Is that right?

Mr. SIKES. That is correct. That is applicable to the end use application that we are talking about.

Mr. ROHRABACHER. So in terms of electronic technology, we lead the Japanese when it comes to computers and they lead us when it comes to television technology. Is that right?

Mr. SIKES. I think that's approximately true. I think it's hard to deal too simplistically, however, with these characterizations.

Mr. ROHRABACHER. But you do believe we are far behind when it comes to high definition television technology, behind the Japanese?

Mr. SIKES. No, I did not say that. I don't believe we are far behind.

Mr. ROHRABACHER. All right. Well, let me ask you about communications technology, an alternative to this competitive situation that's based on another technology which is digital technology, which you alluded to, which is based on computer electronics rather than television electronics.

Do we have a potential there of competing with the Japanese in this area rather than trying to meet them head on in the area of strength which is television technology?

Mr. SIKES. Yes. I think that is a very important point.

Mr. ROHRABACHER. I'm sorry, Mr. Chairman. Am I taking too much time here?

The CHAIRMAN. Well, you were taken out of context, so as far as I'm concerned I'm going to give you another minute. That doesn't happen often, but you're going to get another minute.

Mr. ROHRABACHER. All right. I didn't understand that.

The CHAIRMAN. No, it's all right. I understand. Go ahead.

Mr. ROHRABACHER. I'd just like to ask whether or not you think the United States should be looking to compete with the Japanese in the high resolution area or high definition area, or should we try to leap-frog them and go into a whole different area, competition in the digital area which is based on computer technology?

Mr. SIKES. I think that first of all, there are efforts in that respect today, so it's not something that we have to jump-start.

Secondly, I assume the Japanese are working in digital technology as well, so they are not, I would imagine, asleep in this area. Additionally, I think that there is perhaps a preoccupation with

the Japanese and a failure to acknowledge that there is a significant European effort underway as well.

The CHAIRMAN. Would the gentleman yield?

Mr. ROHRABACHER. Could I have one final question?

The CHAIRMAN. Would the gentleman yield?

Mr. ROHRABACHER. Yes, sir.

The CHAIRMAN. I think that the gentleman is striking a point which we should not just—I have been waiting for that question to come out—that we should not just be jumping over the top of that. I hope that when we get the commercial panel, the fellows that are operating the businesses, I'm going to ask that question myself.

And I believe Mr. Ritter just commented to me, what was it, that the Japanese have put—

Mr. RITTER. If the gentleman would yield, according to Robert Cohen's testimony the other day at the Telecommunications and Finance Subcommittee, the Japanese are talking about putting a \$700 million program together for flat screen technology and the use of digital.

The CHAIRMAN. And I think the gentleman was striking a point—maybe we can carry it out with the next panel—that the digital relationship, the computer relationship in this person's judgment is extremely important to where we're going in the whole system.

The gentleman from California is recognized.

Mr. ROHRABACHER. Thank you, Mr. Chairman.

Just one last question. That is, are there roadblocks that you see that are political roadblocks that we should focus on to make sure that America can reach its potential in the digital area?

Mr. SIKES. I don't have specific thoughts about political roadblocks. I think we could run the risk of stimulating activity on yesterday's technology, stimulating catch-up sort of efforts rather than leap-frogging sort of efforts, and I think that would be mistaken.

Mr. ROHRABACHER. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. I appreciate and thank the gentleman.

If I could ask a question of Dr. Fields for the record: From your observation of the proposals that you are reviewing now, are any of them substantively in digital at all?

Dr. FIELDS. Yes, absolutely. There is very strong representation in the digital area and from the computer industry.

The CHAIRMAN. I thank the gentleman.

The Chair recognizes the distinguished gentlelady from Maryland, the Honorable Connie Morella, the best-dressed woman in the House.

Mrs. MORELLA. Mr. Chairman, I really appreciate your calling this meeting before the full committee on high definition television. I think it's very important. We had a very stimulating breakfast this morning where you attended, with the caucus being formed on it.

I'm going to make the question brief so we can get on to the other panelists, but it has to do with the opportunity of using the Soviet Union as kind of the neutral testing block for high definition TV. I'm wondering—I understand it has been proposed—I'm wondering what the merits are, whether it would violate COCOM

regulations, and whether it might be a problem with technology give-away?

Any of the gentlemen can answer that, Dr. Fields or Secretary Sikes.

Mr. SIKES. You did not hear "a neutral site" from the Commerce Department.

Mrs. MORELLA. That means you don't like it, right? That if we didn't hear it, that you're against it.

Mr. SIKES. That means that I wouldn't regard it as a neutral site.

Mrs. MORELLA. Okay. That's a response.

Mr. SIKES. Secondly, the COCOM questions are currently being investigated by the Bureau of Export Administration in the Department of Commerce. There is a congressional request pending on that. In fact, I have a copy of the letter here sent by, among others, Congressman Ritter. And I just don't believe I should go beyond the investigation that's underway currently.

Mrs. MORELLA. So there is an investigation then going on right now exploring responding to that possibility with regard to what the security problems, et cetera, will be.

When the investigation is completed, will you share it with this committee also, as well as with Congressman Ritter?

Mr. RITTER. If the gentlelady would yield just for a second, it's not me personally. Our Telecommunications and Finance Subcommittee has been holding hearings on this issue, the whole HDTV issue. And this was quite a subject that was discussed at the last hearing, and so we have made a request on behalf of the subcommittee and we will certainly seek to share it with the Science and Technology Committee.

Mrs. MORELLA. With this full committee. Very good. Fine. Thank you very much.

Thanks, Mr. Chairman.

The CHAIRMAN. All right. We want to thank the panel for your patience and you have been a great help this morning. We will be looking forward to hearing from you further. Thank you very much, gentlemen, for being with us.

Our next panel, Panel Two, if I can ask those good folks to come forward. Dr. Solomon Buchsbaum, Executive Vice President, Customer Systems, AT&T Bell Labs, from the great sovereign State of New Jersey; Mr. Ronald Rosenzweig, President and CEO, Anadigics, also from the great State of New Jersey; Mr. Brett Kingstone, President of the Fiberview Corporation, Boulder, Colorado; Mr. Jerry Pearlman, President and CEO of the Zenith Corporation, Glenview, Illinois; and Mr. Jules A. Bellisio, Division Manager, Digital Signal Processing Research, Bellcore, in Livingston in the great State of New Jersey.

We want to welcome our panel and thank you for your patience this morning, and we will get right on with our work. Members, I am very anxious to hear your response, and the first witness we will call is Dr. Solomon Buchsbaum from AT&T Bell Labs.

**STATEMENT OF DR. SOLOMON BUCHSBAUM, EXECUTIVE VICE
PRESIDENT, CUSTOMER SYSTEMS, AT&T BELL LABS, MURRAY
HILL, NEW JERSEY**

Dr. BUCHSBAUM. Thank you very much, Mr. Chairman.

The CHAIRMAN. If the panel would indulge me for a moment, we are having a bit of a problem in hearing because we are not modern enough to have an advanced loud speaker system, so if will be sure to pull your microphones close when you talk, it's easier for us to hear.

Dr. BUCHSBAUM. Well, the reason you couldn't hear me is because it wasn't turned on.

The CHAIRMAN. That's even a better reason.

Dr. BUCHSBAUM. Thank you, Mr. Chairman, and good morning, ladies and gentlemen. My name is Sol Buchsbaum. I'm an Executive Vice President at AT&T Bell Laboratories. As a representative of AT&T and a member of the Telecommunications and Computer Industries, I thank you for this opportunity to affirm my company's support of a nationally focused HDTV program, and for recognizing the importance of a technology that is vital to the nation's competitive future.

During the past several months, I have been deeply enmeshed in issues relating to HDTV and my company's position in this emerging technology. I would like to share some of the views I have formed as a result.

Let me start with the bottom line. Unless a way can be found, either by industry alone or aided by the government, for United States industry to supply a lion's share of any future domestic HDTV market, we will not only miss the coming HDTV wave, but risk losing the share of the highly-prized telecommunications and computer markets we now do have.

Why do I say that? AT&T, with many others, is in the business of information movement and management, known as IM&M. And High Definition Television and its offshoot technologies, as was said here this morning, have implications on the IM&M business that go far beyond the field of entertainment.

So the term HDTV, or even ATV—advanced television—is a bit of a misnomer. There is a commonality of technologies here and an economy of scale. The HDTV initiative helps set the stage for a broad range of voice data and image capabilities, and we are convinced that the application of these technologies will be widespread in the telecommunications systems of the 1990s.

So I agree with what Mr. Sikes said on this point. In fact, I believe that the HDTV technology will impact the IM&M business in the '90s the way data communications and digital technologies have influenced it during the past decade or two.

Because of the United States' leadership in IM&M, the United States has the technological and production know-how needed to close the HDTV gap. The sophisticated electronic components and signal processing techniques required by HDTV are the very sort now used in our most advanced computers and communications equipment.

Now, we are in some danger of losing all of this, and the prospect is not attractive. To help forestall that prospect, AT&T has entered

into a partnership with Zenith, and you will be hearing from Zenith Chairman Jerry Pearlman in a few minutes. Together, our companies will devote our considerable technological prowess to help ensure that the prospect does not become reality.

From AT&T's point of view, the transmission of HDTV images could have profound implications for the telecommunications networks, and any change in those networks will have an impact on one of our key businesses. We also have a natural interest in consumer electronics with an existing presence in some 80 million American homes, and we have special knowledge of display technologies and of the encoding of video signals.

We, after all, pioneered in 1927 the first transmission, live, of TV images from Washington to New York. And we also have vast experience in setting the standards that knit our systems together, and we want to apply that expertise to the establishment of a workable HDTV standard that will be fair to consumers, manufacturers, and service providers alike.

Finally, we want to support the efforts of Congress, federal agencies such as DARPA and the FCC, trade organizations such as the AEA and the EIA and innovative companies such as Zenith. Those are our interests and goals.

How will we accomplish them? To examine that question, we must look at three specific areas of HDTV technology. They are signal transport, receivers and associate equipment, and related standards. Each has its own set of opportunities and problems and risks.

Today, TV signals are being transmitted in analog form. HDTV signals may well be transmitted digitally. If so, the network will be ready and so will the next generation of communications satellites. And fiber will be an important method of achieving very high quality, feature-rich services for the telephone companies and cable companies. HDTV will be a major step in the introduction into the consumer marketplace of sophisticated digital processors, analog to digital conversion, electronic memories, and signal coding and compression.

The strong position of the United States in the major markets in telecommunications, computers, and military electronics is in large part based on our leadership in those technologies.

There are opportunities and risks in introducing these fundamental technologies into the marketplace. Because of higher sales volumes, the companies and countries that apply these technologies successfully will have a larger base of operations over which to spread their costs, including their R&D costs. But if these companies are foreign-owned, their countries could overtake the United States' lead in these key technologies and displace us in the computer, telecommunications, military electronics and semiconductor industries.

The Japanese may excel in the current technologies of consumer electronics, but the United States still has great strength in the advanced technologies I have just described. We could use this advantage to reestablish an important American industry, and this benefit could extend beyond the consumer electronics business.

The remaining critical aspect of HDTV technology is the issue of standards, already alluded to this morning. I strongly believe that

in the standards arena, the United States should fend for itself and cater to its own interests first and foremost.

Now, the same standards need not apply for all transmission media. This is an open issue which needs concerted study, but also speedy resolution. The overarching goal is that a consuming public derive the highest value or quality of image and audio at the lowest cost.

Essentially, there are three types of standards that must be set, and set early. They have to do with production, with transmission and with display. There are many innovative proposals on the table now, such as Zenith's spectrum compatible system. They need to be evaluated quickly and action taken. Completing that task by the end of 1990 would be a nice Christmas present that year to all.

Now, we need to streamline and expedite the standard setting process. This is one area where the government should exercise greater authority and responsibility, in my humble view.

Now, AT&T, for one, is anxious to proceed on many fronts, including the standards front. For one, we have submitted a joint HDTV proposal to DARPA, with Zenith as the prime contractor. DARPA support is extremely important to the AT&T/Zenith partnership. It would enable us to proceed at a pace responsive to the increasingly competitive HDTV forces. But we do need your help elsewhere as well.

For this country to optimize its position and to take advantage of its resources, we need a relationship between business and government that supports long-term speculative technology and entrepreneurship. That can happen if you encourage investment in R&D and in plant, if you encourage risk in cost-sharing relationships for both technology development and commercialization, if you enforce a level playing field regarding technology trade, if you help assure that standards are set in a timely way—and, as I said, having agreed upon standards by year-end 1990 would be a Christmas present that all of us would enjoy—and if you provide seed funding and technology leadership in key areas such as that embodied in the DARPA HDTV program.

Now, section 5131 of the Omnibus Trade and Competitiveness Act of 1988 is certainly a good step toward a coherent national strategy and would stimulate development of just such technologies as HDTV. The bill submitted by Congressmen Ritter and Levine is another very important and welcome step.

I have not yet seen Congressman Brown's bill, of which I just learned this morning, but knowing Congressman Brown's fine work, I have no doubt that I will like that bill as well.

Finally, you can encourage U.S. companies to involve themselves in HDTV through such forums as Secretary Mosbacher's committee.

To conclude, I will repeat my bottom line. It is imperative that the U.S. industry play a significant role in the development and production of HDTV. Too much is at stake for us not to do so.

Thank you for your attention, Mr. Chairman.

The CHAIRMAN. I thank the distinguished witness. I also want to note for the record that he is also Chairman of the White House Science Counsel, and we appreciate all your efforts on our behalf.

You are also from New Jersey. That's even more important.

Dr. BUCHSBAUM. I would like to submit my written statement, which is somewhat longer, for the record.

The CHAIRMAN. Without objection, so ordered.

[The prepared statement of Dr. Solomon Buchsbaum follows.]

STATEMENT BY
SOLOMON J. BUCHSBAUM
EXECUTIVE VICE PRESIDENT
AT&T BELL LABORATORIES

TO THE
UNITED STATES HOUSE OF REPRESENTATIVES'
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
MARCH 22, 1989

As a representative of AT&T, I would like to thank the Committee on Science, Space and Technology for this opportunity to affirm my company's enthusiastic support of a nationally-focused HDTV program.

And as a member of the telecommunications and computer industries, I want to thank you for recognizing the importance of an effort that is vital to the nation's competitive future.

During the past several months, I have been deeply enmeshed in issues relating to HDTV and my company's position in this emerging technology. I would like to share with the Committee some of the views I have formed as a result of that involvement.

Let me start with the bottom line. Unless a way can be found - either by industry alone or aided by the government -for U.S. industry to supply a lion's share of any future domestic HDTV market, we will miss not only the coming HDTV wave, but even risk losing our present share of the highly prized telecommunications and computer markets.

Why do I say that?

My company, with many others, is in the business of information movement and management - known as IM&M. High-definition television and its offshoot technologies, products and services have implications on the IM&M business that go far beyond the field of entertainment. HDTV may well impact the IM&M business during the 1990's the way data communications and digital technology have impacted it during the 80's.

Right now, Japan and Europe are ahead of us in HDTV, but the U.S. has the technological and production know-how needed to close that gap. The very sophisticated electronic components and signal processing techniques required by HDTV are the very sort now used in our most advanced computers and telecommunications equipment.

The prospect of losing all this is not an attractive one. To help forestall that prospect, AT&T has entered into a partnership with Zenith. We will bring to that partnership our considerable technological prowess to help ensure that the prospect does not become reality.

U.S. makers of telecommunications and computer equipment stand ready for the HDTV business. We are movers and managers of information. We arranged the technological marriage of computers and communications, and we can broker the wedding of the telecommunications and entertainment equipment industries. There

is a commonality of technologies and an economy of scale.

From the AT&T point of view, the transmission of HDTV images could have profound implications for the telecommunications networks, and any change in the networks would have an impact on one of our key businesses. HDTV is but one step in the evolution of image communications, and the HDTV initiative helps set the stage for a broad range of voice/data/image capabilities far beyond those associated with entertainment. We are convinced that the application of these technologies will be widespread in telecommunications systems of the 1990's. So the term HDTV is a bit of a misnomer.

AT&T also has a natural interest in consumer electronics, with an existing telecommunications, home control and home office presence in some 80 million American homes. We are a major inventor, manufacturer and seller of electronic components that will be needed for HDTV, and we have special technical knowledge of display technologies and of the encoding of video signals.

For a hundred years, the telecommunications industry has been setting the standards that knit our systems together, and we want to apply that expertise to the expeditious establishment of thoughtful and workable HDTV standards that will be fair to U.S. consumers, manufacturers and service providers alike.

Finally, we want to support the efforts of Congress, federal agencies such as DARPA and the FCC, trade organizations

such as the American Electronics Association and Electronic Industries Association, and innovative companies such as Zenith.

Those are our interests and goals. We hope they are yours as well. Will we accomplish them?

To examine that question, we must look at three specific areas of HDTV technology: signal transport, receivers and associated equipment, and standards. Each has its own set of opportunities.

Our interest in signal transport is obvious. AT&T is both a provider of long-haul service to the TV networks, and a provider of transmission equipment and systems to the telephone companies and cable companies. We want to stimulate use of the network, and HDTV will certainly encourage that use through entertainment and business applications.

Today, TV signals are being transported in analog form. HDTV signals of the future may well be transported in digital form. If so, the network will be ready. For reasons that have nothing to do with HDTV, the networks for signal transport are already evolving toward the fast, broad highways that HDTV will need. By 1992, considered by some to be the start date of HDTV, nearly 100 percent of the AT&T network will be digital. So in a sense, the networks are becoming HDTV-ready -- just as the next generation of communications satellites will be.

Fiber will play an important role in HDTV transport as well as in voice and data transmission. It promises to be an important method of achieving very high-quality, feature-rich services. The telephone companies and cable companies are beginning to install fiber to central hub locations that are located near their subscribers' homes, and there are a growing number of fiber-to-the-home field trials by the regional Bell companies, including Bell Atlantic in New Jersey, and BellSouth in Orlando and Memphis.

HDTV equipment will make full use of sophisticated digital integrated circuits such as those used in digital telephony. HDTV will be a major step in the introduction into the consumer marketplace of sophisticated signal processors, analog to digital conversion, electronic memories, and signal coding and compression. The strong position of the U.S. in the major markets of telecommunications, computers and military electronics is, in large part, based on our leadership in these technologies.

There are opportunities and risks in introducing these fundamental technologies into the marketplace.

Because of higher sales volume, the companies and countries that apply these technologies successfully will have a larger base of operations over which to spread their costs than those who do not apply them. But if most of the companies in HDTV are foreign-owned, those countries could overtake the U.S. lead in key technologies and displace the U.S. in the computer,

telecommunications, military electronics and semiconductor industries.

The Japanese may excel in the current technologies of consumer electronics, but the U.S. still has great strength in the advanced technologies I've just described. We could use this advantage to re-establish an important American industry, and this benefit could extend beyond the consumer electronics industry.

The last critical aspect of HDTV technology is the issue of standards. Standards are the rules-of-the-road for the producers of HDTV programs, for the companies that will carry HDTV signals to their customers, and for the manufacturers of HDTV sets. Not long ago, the U.S. government participated in talk and some action about a single worldwide HDTV standard applicable to all. That issue is essentially moot, since the Europeans chose not to adopt the standard being promulgated by the Japanese.

I strongly believe that, in the standards arena, the U.S. should fend for itself and cater to its own interests - paying heed, of course, to what Japan and Europe are doing. A clear set of ground rules or characteristics is absolutely essential to providing HDTV to the home over various transmission media, whether it be local broadcast, satellite, fiber, coaxial cable or VCR. The same standards need not apply for all media. That is still an open issue: it needs concerted study but also speedy resolution.

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The important goal is that the consuming public derive the highest value or quality of image and audio at the lowest cost.

This overarching goal dictates a complex set of tradeoffs: an HDTV signal that is compatible with existing TV sets, able to fit within the broadcast spectrum, easy to convert, at minimum possible cost, and having the highest practical quality. Those goals don't match those of Japan, particularly in regard to compatibility with existing sets and the effective use of the broadcast spectrum.

Essentially, there are three different types of standards that must be set - and set early. They are production, transmission and display. There are many innovative proposals on the table now, such as Zenith's spectrum-compatible system. They need to be evaluated quickly, and action taken. Completing that task by the end of 1990 would be a nice Christmas present to all.

We need to streamline and expedite the standards-setting process. This is one area in which the Government should exercise greater responsibility and initiative. Unnecessary delay in establishing an HDTV standard reduces our chances for success. Europe, for example, has a far more diverse set of players to contend with, yet they have established standards for both next-generation cellular telephones and HDTV. The U.S. currently has neither.

And we need a uniform testing procedure to evaluate quality and make the necessary tradeoffs in cost, features, quality and marketplace.

AT&T is anxious to proceed on many fronts including the standards front. Not only are we working hard on the basic technologies, but, when appropriate, we will exploit our leadership position in several of the key HDTV technologies by selling electronic components and subsystems to HDTV manufacturers.

Our partnership with Zenith is a step toward facilitating application of those technologies to commercial television.

We have submitted a joint HDTV controller proposal to DARPA with Zenith as the prime contractor. DARPA's support is extremely important to the AT&T-Zenith partnership; it would enable it to proceed at a pace responsive to the increasingly competitive HDTV forces.

We have also submitted a separate proposal to develop our plasma panel technology that could lead to lower-cost high-resolution screens. Development of the next generation of display technology is an element of HDTV that still needs a considerable amount of R&D.

Now we need your help. For this country to optimize its position and take advantage of its resources, we need a relationship between business and government that supports long-term, speculative technology and entrepreneurship.

That can happen if you encourage investment in R&D and plant, if you encourage risk and cost-sharing relationships for both technology development and commercialization, if you enforce a level playing field regarding technology trade, and if you provide seed funding and technology leadership in key areas, such as that embodied in the DARPA HDTV program.

Section 5131 of the Omnibus Trade and Competitiveness Act of 1988 is certainly a step toward a coherent national strategy, and would stimulate development of just such technologies as HDTV. And the bill submitted by Congressmen Ritter and Levine is another important step.

And finally, you can encourage U.S. companies to involve themselves in HDTV through such forums as Secretary Mosbacher's committee.

Let me repeat my bottom line. It is imperative that U.S. industry play a significant role in the development and production of HDTV. Too much is at stake not to.

Thank you for your attention.

SOLOMON J. BUCHSBAUM
AT&T BELL LABORATORIES

Solomon J. Buchsbaum is Executive Vice President, Customer Systems, at AT&T Bell Laboratories in Holmdel, New Jersey.

A physicist by training, Dr. Buchsbaum has been active in national science policy advisory circles, serving on more than a dozen advisory councils concerned with defense, energy and the state of American science. He has published 50 papers in plasma and solid state physics and has been issued eight patents.

In his current position, Dr. Buchsbaum is responsible for product realization planning and engineering, government systems, and architectural framework for AT&T products, systems and services.

Dr. Buchsbaum joined Bell Laboratories in 1958 and performed theoretical and experimental research in gaseous and solid state plasmas. He became Head of the Solid State and Plasma Physics Research Department in 1961 and Director of the Electronics Research Laboratory in 1965. Dr. Buchsbaum left Bell Laboratories in 1968 to become Vice President in charge of research at the Sandia Laboratories of Sandia Corporation, then a subsidiary of Western Electric Company. He returned to Bell Laboratories in 1971 as Executive Director, Research, Communication Principles Division; that same year he was named Executive Director, Research, Communications Sciences Division. In 1975 he became Executive Director of the Transmission Systems Division and in 1976, Vice President of the Network Planning and Customer Services Area. Dr. Buchsbaum assumed his present position in May 1979.

Dr. Buchsbaum is currently serving as Chairman of the White House Science Council and as a senior consultant of the Defense Science Board. He is also a member of the MIT Corporation Development Committee, the MIT Lincoln Laboratory Advisory Board, the Stanford University School of Engineering Advisory Council, Argonne National Laboratory - Board of Governors and director at Draper Laboratory Corporation, Sandia National Laboratories as well as a trustee of the Rand Corporation. He has been a consultant to the Office of Science and Technology Policy and a member of the Energy Research Advisory Board, the Energy Research and Development Agency's Fusion Power Coordinating Committee, the President's Science Advisory Committee, the Naval Research Advisory Committee, the White House Advisory Group on Technical Advances, the Office of Technology Assessment's Health of the Scientific and Technical Enterprise Advisory Panel, Council of the National Academy Engineering and a trustee of Argonne Universities Association. He served as associate editor of the Review of Modern Physics, the Physics of Fluids and the Journal of Applied Physics and as chairman of the Division of Plasma Physics of the American Physical Society, the Defense Science Board and the Energy Research Advisory Board.

He is a member of the National Academy of Engineering and the National Academy of Sciences, and a Fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Physical Society, and the Institute of Electrical and Electronics Engineers. Among his awards and honors are the Anne Molson Gold Medal (McGill University), the Secretary of defense Medal for Outstanding Public Service (1977), the Secretary of Energy Award for Exceptional Public Service (1981), the National Medal of Science (1986) and the Frederik Philips Aware IEEE (1987).

Dr. Buchsbaum received his B.S. and M.S. degree from McGill University in 1952 and 1953, respectively. He received his Ph.D. in physics from the Massachusetts Institute of Technology in 1957.

The CHAIRMAN. The Chair recognizes now the distinguished gentleman, Mr. Ronald Rosenzweig, President and CEO of Anadigics—is that correct—from Warren, New Jersey.

Mr. ROSENZWEIG. We combine both the analog and digital worlds in our little entrepreneurial company in New Jersey.

**STATEMENT OF MR. RONALD ROSENZWEIG, PRESIDENT AND CEO
ANADIGICS, WARREN, NEW JERSEY**

Mr. ROSENZWEIG. It is my pleasure to address this panel on behalf of the American Electronics Association. The remarks I'll make today are sort of highlights from the written testimony that we would like to submit for the record.

The CHAIRMAN. No objection, so ordered.

Mr. ROSENZWEIG. And that includes, by the way, a study that was made by the AEA on the overall economic impact of HDTV on multiple industries.

I am President and Chief Executive Officer of Anadigics, a company I helped establish four years ago in Warren, New Jersey. New Jersey, those representatives from Silicon Valley should be reminded, is the home of Sarnoff, Edison, and it is also where the semiconductor was invented.

The CHAIRMAN. And the chairman of this committee.

Mr. ROSENZWEIG. And the chairman of this committee.

[Laughter.]

Mr. ROSENZWEIG. Certainly a state that can stand tall in the world of high technology.

Anadigics now employs 65 people and most importantly is at the cutting edge of commercializing a new class of high-speed, wide bandwidth components called gallium arsenide integrated circuits. Anadigics' GaAs ICs are directly related to four of the 22 technologies designated as critical to national security and "the long-term qualitative superiority of U.S. weapons systems" in the recent released report by Departments of Defense and Energy.

Anadigics, in the true American entrepreneurship manner, is an independent company that has been financed by private venture capital as well as some corporate investment. We have to date received relatively little financial support from the U.S. or state governments and, as such, we are keenly aware of the economics of relying solely on private investment to commercialize a state-of-the-art high-risk technology that is strategically important to the economic competitiveness and national security interests of the U.S., especially technologies that do not bring immediate financial return.

Anadigics' products are directly related to the field of high definition television because high definition television signals require much more bandwidth than conventional television signals and therefore will require wider bandwidth transmission and reception systems than conventional TV.

Anadigics' GaAs ICs can be used in the wide band distribution of high definition television signals via fiber optic communications or direct broadcast satellite. And as a result, we are very interested in the development of the HDTV industry in the United States.

Because of this, Anadigics is a member of the American Electronics Association ATV Task Force and has also invested money as part of its HDTV business plan group, of which I will say a little bit more later.

The American Electronics Association is the largest national trade group representing electronics and information technology companies. AEA's 3,500 member companies are located in 39 states, the District of Columbia, Puerto Rico, and Canada. They are the companies that design, manufacture, or conduct research in electronics, electronic components and related information technology products.

In addition, 48 major U.S. universities are associate members of AEA, a reflection of AEA's longstanding effort to strengthen U.S. university/industry relationship.

I would like to very briefly summarize what AEA has done in just the past 10 months. In May of 1988, an ATV Task Force was formed which now reports directly to the National Board of AEA. In November, the High Definition Television Economic Impact Report was submitted, which indicated not only the impact of HDTV as an industry on the U.S. economy, but also its impact on such products as semiconductors, personal computers, automated manufacturing, and also its impact on the defense.

This has led in January of '89 to 36 AEA companies forming to fund a business plan which is being put together right now by the Boston Consulting Group. I think what is critically important as we talk about the amount of investment required for the United States to get back into consumer electronics and TV is to really determine what the financial parameters are, and we hope that that will be one of the major outputs of this report.

That report is scheduled to be completed in May, and a first meeting of the report group will be held next week in Washington.

I think, as has been eloquently stated by many people earlier in the day, clearly the big deal about ATV can be told, I think, in two or three different areas. One, as the Japanese have indicated, they claim by the year 2000 it will be a \$25 billion a year industry. Many forecasts indicate anywhere from \$40 billion to \$100 billion per year in the early part of the 21st century. That's big business by anybody's terms.

The U.S. now is a major consumer of televisions. We consume about 25 to 30 percent of the TVs in the world, but we no longer manufacture or, except for Zenith which we will hear about, manufacture very, very few. Obviously, ATV will have a profound effect on the U.S. balance of trade.

Number two, HDTV is a major factor in developing critical new technologies, technologies that can be used not only to help our national defense posture, national security, but also will—as we indicated before—are very, very important in helping to develop the telecommunications industry as well the computer industry, so there is a tremendous amount of spillover.

Therefore, HDTV or ATV becomes a dual use technology, one that is critically important for defense and national security, as well as important to our overall economic posture.

Clearly, the U.S. does not alone recognize this and, as we indicated, as has been indicated before, both Japan and even Europe is

well out in front on this issue. I think we can say that the U.S. is in a global dogfight and is now somewhat an underdog as a producer of TVs.

The stakes are high; the competition is formidable. And I think that means that we have to, in a sense, get our act together. What that means is policies must recognize that in today's global marketplace, countries and economies compete, not just individual companies. Therefore, what must be established is cooperation and collaboration between companies and the government and that must replace adversarial relationships.

I think it is clear that U.S. companies, by and large, make their resource allocations in a rational manner and the key now is establishing a return on investment posture that will make sense for individual U.S. companies to enter the TV industry. Also, because of the reduced consumer infrastructure that now exists, special measures must be required for the U.S. to compete in ATV.

Options that Congress should consider are:

1. Encouraging industry-led consortia by revisiting antitrust laws and providing specific exemptions for new joint high-tech ventures like ATV.
2. Increased funding for DARPA R&D. Investing in research and development is a prerequisite for meaningful participation in the total ATV market process.
3. Funding the newly-established National Institute of Standards and Technology and their Advanced Technology Program for taking commercial aspects that emerge from DARPA's R&D and conducting prototype manufacturing of ATV commercial products.

I think what is critically important is that we recognize that HDTV is a dual use technology. This is particularly true when a technology and industrial infrastructure supports both the national defense and security of this country as well as our overall industrial growth, which means trade, and both of those are tied together through a common technology.

In the last decade of this century, I think it is clear more than ever that national security and economic competitiveness are one and the same.

I think there are wonderful examples in what DARPA has been able to accomplish both with the support of SEMATECH, which is probably the first model of a dual use funding, and that ATV support falls in the same area of supporting dual use technologies.

I think we should be tremendously encouraged by the 87 responses to the ATV broad area announcement that recently took place, and I think that is tremendous evidence of the effectiveness of the catalytic approach of providing funds for ATV research, and it is a strong signal to industry that there is a friend now in Washington that can support and help them in this very, very difficult task, and AEA strongly supports these efforts.

But this is clearly a commercial issue as well as technology issue, and NIST and the Department of Commerce can play a very, very important role in that. The Department of Commerce has a broad mandate to assist U.S. business and industrial technology development. A primary tool for financing and coordinating these civilian technology developments are the National Institute of Standards and Technology and the Advanced Technology Program, and dual

use technologies such as ATV that meet both civilian and defense needs should be developed under the auspices of DoD and DoC in conjunction with industry-led concepts which AEA can play a very, very important role.

AEA has been working with many groups, particularly the IEEE under the leadership of Professors Dave Stalen and Alan McDams, to explore the establishment of a national model for industry-led consortia involving both civilian and defense government agencies. This model contains three key entities. It begins with an industry-led consortia of companies and then recognizes the cross-over between federal, civilian, and military R&D by involving both the Defense Department and the Department of Commerce.

Congressional support for this structure through such actions as providing the requisite funds—and I think, after all, we must recognize that the reason we are here today is talking about resource allocation, and all of the good words without the funding behind it really will not get us where we have to go—the requisite funds for DARPA and NIST will be critical to its success.

If we take this model and apply it to ATV, we have AEA's effort to develop this industry-led consortia and, with the support of Congress, DARPA underwriting the R&D effort and NIST sponsoring the prototype manufacturing effort, the funding of dual use technologies by both DoD and DoC can maximize our resources and greatly benefit our economy and national security. DARPA and NIST could identify special joint projects with which to advance their support of dual use initiatives.

Personnel could be supplied by both agencies. With the bulk of the technology assessment and procurement being handled initially by DARPA personnel trained in the rapid funding of high technology initiatives, it is envisioned that DARPA and NIST would separately fund their respective program elements.

Industry oversight would be needed to monitor and disseminate lessons learned by this enterprise. Industry oversight would be particularly critical for providing the general program direction and policies and would advise the government on their effectiveness.

AEA strongly believes that this is a promising model for bringing industry and government together to successfully compete in the global marketplace. We look forward to working with Congress to promote such a structure.

[The prepared statement of Ronald Rosenzweig follows.]

INDUSTRY, GOVERNMENT, AND ATV

TESTIMONY OF
RONALD ROSENZWEIG
PRESIDENT AND CEO
ANADIGICS
ON BEHALF OF THE
AMERICAN ELECTRONICS ASSOCIATION
BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MARCH 22, 1989

MR. CHAIRMAN, MEMBERS OF THE COMMITTEE, MY NAME IS
RON ROSENZWEIG. I AM PRESIDENT AND CHIEF EXECUTIVE OFFICER OF
ANADIGICS, A COMPANY I HELPED ESTABLISH FOUR YEARS AGO IN
WARREN, NEW JERSEY. ANADIGICS NOW EMPLOYS 65 PEOPLE AND IS AT
THE CUTTING EDGE OF COMMERCIALIZING A NEW CLASS OF HIGH SPEED,
WIDEBANDWIDTH COMPONENTS CALLED GALLIUM ARSENIDE INTEGRATED
CIRCUITS (GaAs ICs). ANADIGICS' GaAs ICs TECHNOLOGY IS DIRECTLY
RELATED TO 4 OF THE 22 TECHNOLOGIES DESIGNATED AS CRITICAL TO
NATIONAL SECURITY AND "THE LONG TERM QUALITATIVE SUPERIORITY OF
U.S. WEAPONS SYSTEMS" IN THE RECENTLY RELEASED REPORT BY THE
DEPARTMENTS OF DEFENSE AND ENERGY.

ANADIGICS IS AN INDEPENDENT COMPANY THAT HAS BEEN FINANCED
BY PRIVATE VENTURE CAPITAL AND CORPORATE INVESTMENT. WE HAVE TO
DATE RECEIVED RELATIVELY LITTLE FINANCIAL SUPPORT FROM THE U.S.
GOVERNMENT. AS SUCH, WE ARE KEENLY AWARE OF THE ECONOMICS OF
RELYING SOLELY ON PRIVATE INVESTMENT TO COMMERCIALIZE A STATE-OF-
THE-ART, HIGH RISK TECHNOLOGY THAT IS STRATEGICALLY IMPORTANT TO
THE ECONOMIC COMPETITIVENESS AND NATIONAL SECURITY INTERESTS OF
THE U.S.

NOT ONLY ARE ANADIGICS' GaAs ICs AN INTEGRAL PART OF THIS COUNTRY'S CRITICAL TECHNOLOGIES, BUT OUR PRODUCTS HAVE IMPORTANT IMPLICATIONS FOR ADVANCED/HIGH DEFINITION TELEVISION (ATV/HDTV). HDTV SIGNALS REQUIRE MORE BANDWIDTH THAN CONVENTIONAL TELEVISION, AND THEREFORE WILL REQUIRE WIDER BANDWIDTH TRANSMISSION AND RECEPTION SYSTEMS THAN CONVENTIONAL T.V. ANADIGICS GaAs ICs CAN BE USED IN THE WIDEBAND DISTRIBUTION OF HDTV SIGNALS VIA FIBER OPTIC COMMUNICATIONS AND DIRECT BROADCAST SATELLITE T.V. (DBS). AS A RESULT, WE ARE VERY INTERESTED IN THE DEVELOPMENT OF THE HDTV INDUSTRY IN THE U.S.

ANADIGICS ALSO IS A MEMBER OF THE AMERICAN ELECTRONICS ASSOCIATION'S (AEA) ATV TASK FORCE AND ITS HDTV BUSINESS PLAN GROUP.

I AM PLEASED TO HAVE THIS OPPORTUNITY TO TESTIFY ON BEHALF OF AEA. THE AMERICAN ELECTRONICS ASSOCIATION IS THE LARGEST NATIONAL TRADE GROUP REPRESENTING ELECTRONICS AND INFORMATION TECHNOLOGY COMPANIES. AEA'S 3,500 MEMBER COMPANIES ARE LOCATED IN 39 STATES, THE DISTRICT OF COLUMBIA, PUERTO RICO AND CANADA. THEY ARE THE COMPANIES THAT DESIGN, MANUFACTURE OR CONDUCT RESEARCH IN ELECTRONICS, ELECTRONIC COMPONENTS, AND RELATED INFORMATION TECHNOLOGY PRODUCTS. IN ADDITION, 48 MAJOR U.S. UNIVERSITIES ARE ASSOCIATE MEMBERS OF AEA, A REFLECTION OF AEA'S LONGSTANDING EFFORT TO STRENGTHEN OUR U.S. UNIVERSITY-INDUSTRY RELATIONSHIP.

AEA'S HDTV DIARY

MUCH HAS HAPPENED SINCE AEA LAST TESTIFIED ON HDTV BEFORE THE COMMITTEE'S SCIENCE, RESEARCH, AND TECHNOLOGY SUBCOMMITTEE IN JUNE 1988. IT WAS ONLY A FEW MONTHS PRIOR TO THE SUBCOMMITTEE'S HDTV HEARING LAST YEAR THAT AEA BECAME INVOLVED IN THIS ISSUE. LAST MAY, AN AEA AD HOC ATV TASK FORCE BEGAN STUDYING ECONOMIC COMPETITIVENESS ISSUES OF ATV. A MONTH LATER, AEA HELD AN ATV INFORMATION MEETING ATTENDED BY SOME FIFTY GOVERNMENT AND INDUSTRY EXECUTIVES. FROM THIS MEETING, A 28-MEMBER AEA ATV TASK FORCE WAS ESTABLISHED. THE TASK FORCE WAS QUICKLY ELEVATED TO REPORT DIRECTLY TO AEA'S BOARD OF DIRECTORS, REFLECTING THE BOARD'S VIEW OF ATV'S POTENTIAL IMPACT ON THE BROAD ELECTRONICS INDUSTRY.

AEA SET UP ITS OWN STUDY GROUP AND PUBLISHED IN NOVEMBER THE HDTV ECONOMIC IMPACT REPORT, A COPY OF WHICH I WOULD LIKE TO SUBMIT FOR THE RECORD. THE REPORT ANALYZED POTENTIAL HDTV MARKETS, CONSIDERED THE POSSIBLE IMPACT OF HDTV ON THE U.S. MARKETSHARE IN THREE INDUSTRY SEGMENTS -- PERSONAL COMPUTERS, SEMICONDUCTORS, AND AUTOMATED MANUFACTURING EQUIPMENT, AND ESTIMATED POSSIBLE COSTS FOR NEW U.S. ENTRANTS TO BUILD THE MANUFACTURING INFRASTRUCTURE NECESSARY TO PRODUCE HDTV PRODUCTS.

AS AN OUTGROWTH OF THE TASK FORCE, 36 AEA MEMBER COMPANIES RECENTLY JOINED TOGETHER AS A GROUP TO FUND THE DEVELOPMENT OF A BUSINESS PLAN FOR U.S. PARTICIPATION. THE PURPOSE OF THIS PLAN

IS TO DEFINE A STRUCTURE AND AN INVESTMENT STRATEGY FOR INDUSTRY TO ACHIEVE U.S. PARTICIPATION IN ATV AND RELATED MARKETS. THIS STRATEGY WILL CONTAIN RECOMMENDATIONS FOR GOVERNMENT ACTIONS TO REDUCE THE FINANCIAL RISK INHERENT FOR U.S. PARTICIPATION. LAST MONTH, AEA SELECTED THE BOSTON CONSULTING GROUP TO DEVELOP THE BUSINESS PLAN, WHICH IS SCHEDULED FOR A MID-MAY COMPLETION DATE TO ACCOMMODATE THE FISCAL YEAR 1990 CONGRESSIONAL BUDGET CYCLE.

IN ADDITION TO THIS MAJOR UNDERTAKING, AEA IS PARTICIPATING AS A MEMBER OF THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS' "IEEE-USA TECHNOLOGY ACTIVITIES COUNCIL" AD HOC WORK GROUP ON HDTV. THIS GROUP HAS BEEN HELPFUL IN COALESCING DIVERSE VIEWS ON ISSUES SUCH AS HOW A PRIVATE/PUBLIC R&D CONSORTIA MODEL MIGHT BE DEVELOPED.

THE PICTURE OF ATV

AT THE RISK OF "PREACHING TO THE CHOIR", LET ME QUICKLY REVIEW WHY, IN TEN SHORT MONTHS, ATV HAS BECOME A PRIORITY ISSUE FOR THE ELECTRONICS INDUSTRY.

THE POTENTIAL MARKET FOR ATV TECHNOLOGIES IS ENORMOUS, WITH CURRENT ESTIMATES RANGING FROM \$40 BILLION TO \$150 BILLION IN TEN TO FIFTEEN YEARS. SUBSTANTIAL PARTICIPATION BY THE U.S. ECONOMY IN ATV IS VITAL TO AMERICAN COMPETITIVENESS ACROSS THE BOARD. PARTICIPATION BY THE U.S. ECONOMY PRINCIPALLY AS

ASSEMBLER, DISTRIBUTOR AND CONSUMER OF ATV PRODUCTS IS NOT SUFFICIENT.

AN IMPORTANT POINT TO REMEMBER WHEN DISCUSSING THE ELECTRONICS INDUSTRY IS THAT IT IS COMPRISED OF MANY INTERDEPENDENT SEGMENTS. A DESCRIPTIVE ANALOGY FOR THE ELECTRONICS INDUSTRY IS THE FOOD CHAIN. THE SURVIVAL OF EACH UNIT IN THE CHAIN -- MATERIALS, MANUFACTURING EQUIPMENT, SEMICONDUCTORS, CIRCUIT BOARDS, COMPUTERS, SYSTEMS, AND SOFTWARE -- IS CRITICAL TO ALL OF THE OTHER ELEMENTS IN THE CHAIN. FOR EXAMPLE, ACCESS TO STATE-OF-THE ART SEMICONDUCTOR TECHNOLOGY IS ESSENTIAL TO THE SUCCESS OF ALL OF THE ELEMENTS FURTHER "UP" THE CHAIN. A LAG IN ACCESS TO THIS TECHNOLOGY BY U.S. COMPANIES ULTIMATELY MEANS A LOSS OF COMPETITIVENESS IN OTHER SECTORS.

THE FOOD CHAIN ANALOGY IS ESPECIALLY IMPORTANT WHEN CONSIDERING THE IMPACT OF HIGH-TECHNOLOGY COMPANIES UPON NATIONAL DEFENSE. U.S. NATIONAL SECURITY STRATEGY IS CURRENTLY DRIVEN BY THE QUEST FOR QUALITATIVE RATHER THAN QUANTITATIVE SUPERIORITY IN DEFENSE SYSTEMS. TECHNOLOGICAL LEADERSHIP IN ALL OF THE INTERCONNECTED SEGMENTS OF THE ELECTRONICS INDUSTRY IS CRITICAL IF THE U.S. IS TO MAINTAIN ITS QUALITATIVE EDGE, PARTICULARLY IN AN ERA OF DECLINING BUDGETS. THIS LEADERSHIP CAN ONLY BE ATTAINED WHEN THE COUNTRY HAS A UNIFORMLY STRONG ECONOMY.

ELECTRONICS IS AMERICA'S LARGEST MANUFACTURING INDUSTRY AND IS GROWING THREE TIMES FASTER THAN ALL OTHER MANUFACTURING INDUSTRIES. OVER 2.6 MILLION AMERICAN WORKERS ARE DIRECTLY EMPLOYED IN ELECTRONICS MANUFACTURING. THIS IS MORE THAN THREE TIMES THE SIZE OF THE AUTO INDUSTRY, AND NINE TIMES THE SIZE OF THE STEEL FABRICATION INDUSTRY (SEE ATTACHMENTS 1 AND 2). THE ELECTRONICS INDUSTRY'S NEARLY \$250 BILLION IN ANNUAL DOMESTIC SALES TRANSLATES INTO ONE U.S. JOB FOR EVERY \$100,000 IN SALES. FURTHERMORE, THE ELECTRONICS INDUSTRY IS LOCATED IN ALMOST EVERY PART OF THE COUNTRY. OVER HALF THE STATES HAVE AT LEAST 20,000 DIRECT MANUFACTURING JOBS IN ELECTRONICS (SEE ATTACHMENT 3).

IF THE U.S. FAILS TO RESEARCH, DEVELOP, DESIGN, ENGINEER, AND MANUFACTURE ATV PRODUCTS AND SERVICES, THE COUNTRY AS A WHOLE IS LIKELY TO EXPERIENCE A CONTINUING DECLINE IN WORLD MARKETSHARE OF AUTOMATED MANUFACTURING EQUIPMENT, PERSONAL COMPUTERS, AND SEMICONDUCTORS. IN ADDITION, TELECOMMUNICATIONS AND OTHER STRATEGICALLY CRITICAL INDUSTRIES COULD FOLLOW. FAILURE TO PARTICIPATE IN ATV WILL MAKE U.S. NATIONAL SECURITY DEPENDENT UPON THE TECHNOLOGICAL CAPABILITIES CONTROLLED BY OTHER NATIONS.

LOSS OF THESE MARKETS WILL CONTRIBUTE TO THE LOSS OF BOTH HIGH-END AND LOW-END AMERICAN JOBS IN NON-CONSUMER ELECTRONICS FIELDS. LOSS OF THESE MARKETS MAY SIGNIFICANTLY INCREASE THE U.S. TRADE DEFICIT AND THE NATIONAL DEBT. AND OVER TIME LOSS OF

THESE MARKETS WILL LEAD TO THE EROSION AND EVENTUAL LOSS OF A U.S. MANUFACTURING AND TECHNOLOGICAL BASE.

THE IMPLICATIONS FOR NATIONAL SECURITY ARE EVIDENT. AS IS HAPPENING IN THE SEMICONDUCTOR INDUSTRY, THE U.S. IS NO LONGER THE PRIMARY INNOVATOR IN SIGNIFICANT END USE ELECTRONICS MARKETS (I.E., A MARKET FOR STAND-ALONE PRODUCTS WHICH HAVE A SIGNIFICANT VALUE TO THE INDIVIDUAL CONSUMER). THIS ECONOMIC DECLINE OVER TIME WILL JEOPARDIZE THE POSITION OF THE U.S.

PREPARE FOR GLOBAL COMPETITION

REPORTS ACCUMULATE ON HOW THE U.S. IS FALLING BEHIND JAPAN AND EUROPE IN RESEARCH AND DEVELOPMENT OF TECHNOLOGIES ESSENTIAL TO INDUSTRIAL AND ECONOMIC SUCCESS IN THE 21ST CENTURY. JAPAN HAS A SIGNIFICANT LEAD IN THE APPLICATION OF ATV TECHNOLOGY AND EUROPE, WITH ITS SEPARATE STANDARDS AND PROTECTION, HAS A BETTER CONSUMER INFRASTRUCTURE THAN THE U.S.

THE JAPANESE GOVERNMENT'S ROLE IN DIRECTING AND COORDINATING INDUSTRIAL RESEARCH IS WELL KNOWN. JAPAN'S COMMERCIAL SUCCESSES IN CONSUMER ELECTRONICS HAVE WON THAT COUNTRY ECONOMIC REWARDS WHICH HAVE BEEN REINVESTED IN MORE RESEARCH, GIVING IT A LEAD IN PRODUCT DEVELOPMENT THAT IS THE ENVY OF MANY. ATV HAS BEEN TARGETED BY JAPAN AS ITS NEXT MAJOR CONSUMER ELECTRONICS PUSH. THE EUROPEAN COMMUNITY IS ALSO PROVIDING COOPERATIVE RESEARCH PROGRAMS AND PROMOTING TRANS-NATIONAL INDUSTRIAL COLLABORATIONS

FOR PROJECTS TOO BIG OR TOO EXPENSIVE FOR INDIVIDUAL COUNTRIES OR COMPANIES. ATV IS ONE EXAMPLE OF EUROPE-WIDE COOPERATION, THE PURPOSE OF WHICH IS TO POSITION EUROPE TO MEET 21ST CENTURY INDUSTRIAL COMPETITION.

IF WE ARE TO COMPETE SUCCESSFULLY IN ATV, THE TRADITIONAL RELATIONSHIP BETWEEN GOVERNMENT AND INDUSTRY MUST ADJUST TO REFLECT TODAY'S GLOBAL ECONOMIC COMPETITION. WE NEED TO CREATE AN ENVIRONMENT WHICH RESTORES U.S. LEADERSHIP IN TECHNOLOGY AND INDUSTRIAL COMPETITIVENESS. AMERICAN BUSINESS AND GOVERNMENT MUST DEVELOP TOGETHER NEW COOPERATIVE NATIONAL STRATEGIES AROUND WHICH THE U.S. CAN RALLY AND SUCCESSFULLY COMPETE WITH OTHER NATIONS.

THE RECIPE FOR ATV

THE U.S. MUST RESPOND TO TODAY'S GLOBAL MARKETPLACE AND DEVELOP AN ENVIRONMENT WHICH SUPPORTS, ENCOURAGES AND ENHANCES U.S. INDUSTRY'S COMPETITIVENESS. U.S. POLICIES AND STRATEGIES MUST RECOGNIZE THAT NOT ONLY DO INDIVIDUAL COMPANIES COMPETE FOR MARKETSHARE, BUT COUNTRIES AND ECONOMIES COMPETE FOR MARKETSHARE AS WELL. ULTIMATELY, THE COMPETITIVENESS OF OUR ECONOMY IS MORE THAN JUST THE SUM OF THE COMPETITIVENESS OF INDIVIDUAL DOMESTIC AND FOREIGN FIRMS OPERATING IN THE U.S. U.S. POLICIES WHICH EFFECTIVELY ADDRESS ECONOMIC COMPETITIVENESS MUST CONSIDER THE EFFECTS OF INVESTMENTS IN EDUCATION, THE INFRASTRUCTURE, BASIC

RESEARCH, AND THE POLICY AND LEGAL ENVIRONMENT THAT PROMOTES OR DISCOURAGES COLLABORATION AMONG INDIVIDUAL FIRMS, UNIVERSITIES, AND GOVERNMENT.

SPECIAL MEASURES WILL BE REQUIRED TO IMPROVE OVERALL U.S. COMPETITIVENESS AND ATV PARTICIPATION IN PARTICULAR. OPTIONS CONGRESS SHOULD CONSIDER INCLUDE:

1. ENCOURAGING INDUSTRY-LED CONSORTIA BY REVISING ANTITRUST LAWS AND PROVIDING SPECIFIC EXEMPTIONS FOR NEW JOINT HIGH-TECH VENTURES LIKE ATV.
2. INCREASING FUNDING FOR DARPA R&D -- INVESTING IN RESEARCH AND DEVELOPMENT IS A PREREQUISITE FOR MEANINGFUL PARTICIPATION IN THE TOTAL ATV MARKET PROCESS.
3. FUNDING NIST'S ADVANCED TECHNOLOGY PROGRAM FOR TAKING COMMERCIAL ASPECTS THAT EMERGE FROM DARPA'S R&D AND CONDUCTING PROTOTYPE MANUFACTURING OF ATV COMMERCIAL PRODUCTS.
4. ENCOURAGING INVESTMENT BY MAKING PERMANENT THE R&D TAX CREDIT AND LOWERING THE CAPITAL GAINS TAX.

5. EXPANDING GOVERNMENT'S ROLE IN THE EXPORT MARKET TO IMPROVE MARKET ACCESS FOR U.S. MANUFACTURED PRODUCTS AND SERVICES AND GENERALLY WORK TO CREATE A MARKET PARITY.

6. INCREASING GOVERNMENT'S ANCILLARY ROLES IN PROMOTING U.S. PRODUCTS ABROAD THROUGH SUCH MEANS AS PROVIDING CREDIT OPTIONS FOR COUNTRIES BUYING AMERICAN-MADE PRODUCTS OR SERVICES, AND ESTABLISHING U.S. TRAINING AND TECHNICAL SERVICES FOR LESS ADVANCED COUNTRIES AS INCENTIVES TO ADOPT U.S. DEVELOPMENTS.

7. ADDRESSING EDUCATION NEEDS BY WORKING WITH ACADEMIA AND INDUSTRY TO BETTER UNDERSTAND AND PROVIDE THE SCIENTIFIC/TECHNOLOGICAL KNOWLEDGE AND SKILLS NECESSARY TO MAINTAIN HIGHLY ADVANCED INDUSTRIES.

8. EXAMINING PATENT POLICIES AND LICENSING RIGHTS TO SUPPORT AMERICAN VENTURES.

ALTHOUGH THE U.S. TRAILS OUR FOREIGN COMPETITORS IN DEMONSTRABLE ATV PRODUCTS, PROPOSALS SUBMITTED TO DARPA, AS WELL AS COMPANIES PARTICIPATING IN AEA'S HDTV BUSINESS PLAN GROUP, INDICATE THAT THE U.S. HAS CONSIDERABLE ATV TECHNOLOGICAL

CAPABILITY. THE U.S. ALSO POSSESSES MANY COMPETITIVE ADVANTAGES, INCLUDING A HUGE HOMOGENEOUS MARKET. WE NEED TO TAKE FULL ACCOUNT OF OUR RELATIVE ADVANTAGES AND DISADVANTAGES TO DEVELOP A BEST-INTEREST STRATEGY AIMED AT MOVING US TOWARD U.S. PARTICIPATION IN THE ATV MARKET. DISCUSSION OF THE IDEAS OUTLINED ABOVE WILL HELP GOVERNMENT AND INDUSTRY FORMULATE A COHESIVE AND EFFECTIVE NATIONAL STRATEGY -- A STRATEGY THAT WILL ENABLE U.S. INDUSTRY TO UNDERTAKE THE FOLLOWING ESSENTIAL ACTIONS:

1. ESTABLISH A U.S. MANUFACTURING CAPABILITY FOR PRODUCTION OF T.V. DISPLAYS AND THE ASSEMBLY OF RECEIVER COMPONENTS.
2. IMPLEMENT A CREATIVE MARKETING STRATEGY THAT CONVINCES CONSUMERS TO BUY AMERICAN ENHANCED OR HIGH DEFINITION T.V., AND A PRICING STRATEGY THAT RECOGNIZES THE JAPANESE "STAYING POWER" WHEN IT COMES TO TARGETING NEW MARKETSHARE.
3. ADOPT A COMPETITIVE DISTRIBUTION STRATEGY BASED ON SHELF SPACE CURRENTLY DOMINATED BY FOREIGN MANUFACTURERS, THAT IS UNDERPINNED BY BETTER U.S. PRODUCT PERFORMANCE AND FEATURES, AND RELIABLE QUALITY SERVICE.

LESSONS FROM ABROAD

OTHER COUNTRIES, SUCH AS JAPAN AND FRANCE, HAVE FACED AND OVERCOME PROBLEMS IN THE GRADUAL EROSION OF THEIR TECHNOLOGY BASE. ONE IMPORTANT LESSON WE MUST LEARN FROM THEM IS THAT WITHOUT THE ACTIVE COOPERATION AND SUPPORT OF THE FEDERAL GOVERNMENT, IT IS VIRTUALLY IMPOSSIBLE FOR A NATION'S INDUSTRY TO DEVELOP AND MAINTAIN DOMESTIC CAPABILITY IN THE FACE OF WELL ESTABLISHED AND AGGRESSIVE COMPETITORS. THE U.S. FEDERAL GOVERNMENT'S SUPPORT, THEREFORE, IS ESSENTIAL AS U.S.-OWNED FIRMS IN CONSUMER ELECTRONICS BECOME ESTABLISHED AND RE-VITALIZED AND BECOME MORE COMPETITIVE. WHEN MATCHING COMPANY AGAINST COMPANY, U.S. INDUSTRY REMAINS A FORMIDABLE COMPETITOR. BUT WHEN U.S. COMPANIES MUST COMPETE AGAINST FOREIGN GOVERNMENTS WORKING WITH COALITIONS OF COMPANIES, THE U.S. DOES NOT COME OUT ON TOP.

JAPAN AND EUROPE VIEW HDTV BOTH IN TERMS OF GLOBAL ECONOMIC COMPETITIVENESS AND AS PART OF A COMPLETE SYSTEM TO PROVIDE INFORMATION IN AN IMPROVED MANNER. HDTV IS, THEREFORE, NOT JUST A NEW TELEVISION SET, BUT RATHER HDTV CAN BE VIEWED AS A TERMINAL AT THE END OF A WIDEBAND COMMUNICATIONS NETWORK. THE CHOICE OF THIS NETWORK IS CRITICALLY IMPORTANT TO THE SUCCESS OF A U.S. RE-ENTRY STRATEGY. FOR EXAMPLE, IN JAPAN HDTV IS NOW BEING TRANSMITTED VIA DIRECT BROADCAST SATELLITE TO THE HOME AND NOT BY CONVENTIONAL BROADCAST. THE EUROPEAN ECONOMIC COMMITTEE IN ITS GOVERNMENT FUNDED "RACE" PROGRAM HAS TARGETED WIDEBAND

FIBER OPTIC NETWORKS AS A MEANS OF DISTRIBUTING HDTV. EUROPE HAS ALREADY DEFINED COMMON DBS TRANSMISSION STANDARDS FOR IMPROVED DEFINITION T.V. WHICH WILL LEAD DIRECTLY TO HDTV IN THE MID 1990'S. A NATIONAL WIDEBAND FIBER OPTIC COMMUNICATIONS NETWORK WOULD NOT ONLY PROVIDE AN EXCELLENT DISTRIBUTION SYSTEM FOR HDTV CHANNELS, BUT WOULD BE INTERACTIVE, CAPABLE OF TRANSMITTING HIGH SPEED COMPUTER DATA AND WOULD FREE-UP OVERCROWDED UHF FREQUENCIES FOR USE IN CREATING INNOVATIVE MOBILE COMMUNICATIONS SERVICES. THIS IS ONE EXAMPLE OF HOW AN HDTV STRATEGY CAN CREATE A DRAMATICALLY IMPROVED TECHNOLOGY BASE IN THE U.S.

DUAL-USE PRODUCTS

A BROAD RANGE OF MILITARY AND CIVILIAN PRODUCTS WHICH ARE VITAL TO U.S. NATIONAL SECURITY AND TO THE FUTURE U.S. STANDARD OF LIVING INCREASINGLY DEPENDS ON OUR ABILITY TO DESIGN AND MANUFACTURE SOPHISTICATED ELECTRONIC SYSTEMS. THE ALMOST TOTAL ELIMINATION OF U.S.-OWNED FIRMS THAT DOMESTICALLY PRODUCE DUAL-USE PRODUCTS -- AND THUS THE LOSS OF DUAL-USE PRODUCT DESIGN AND MANUFACTURING CAPABILITY -- REPRESENTS A GREAT DANGER TO THIS COUNTRY'S MILITARY AND ECONOMIC SECURITY IN AREAS SUCH AS COMPUTERS, TELECOMMUNICATIONS, AUTOMATION, AND MODERN WEAPONRY. MOREOVER, PURCHASING THESE PRODUCTS FROM FOREIGN SUPPLIERS IS CONTRIBUTING TO THE U.S. TRADE DEFICIT. THESE SPILL-OVER EFFECTS FROM CONSUMER ELECTRONICS TO MILITARY AND ECONOMIC SECURITY AREAS

CAN NO LONGER BE IGNORED. ECONOMIC COMPETITIVENESS IS THE NATIONAL SECURITY ISSUE.

AS OUTLINED EARLIER BY DR. FIELDS, THE DEFENSE DEPARTMENT'S (DOD) DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA) PROVIDES CRITICAL SUPPORT FOR THE DEVELOPMENT OF KEY DUAL-USE TECHNOLOGIES (CIVILIAN AND DEFENSE TECHNOLOGIES). DARPA'S SUPPORT FOR SEMATECH AND ATV RESEARCH PROJECTS ARE GOOD EXAMPLES. THE SHEER NUMBER OF ATV-RELATED PROPOSALS RECEIVED BY DARPA DEMONSTRATES THE EXTENT OF INDUSTRY INTEREST IN ATV AND THE ABILITY OF GOVERNMENT TO SERVE AS A CATALYST IN STIMULATING INDUSTRY ACTION. DARPA HAS BEEN QUITE SUCCESSFUL IN DEVELOPING PERSONNEL AND PROCEDURES WHICH ARE UNIQUE WITHIN GOVERNMENT FOR THEIR SPEED AND EFFECTIVENESS IN PROMPT AND APT FUNDING OF HIGH TECHNOLOGY OPPORTUNITIES. AEA STRONGLY SUPPORTS THESE EFFORTS.

THE COMMERCE DEPARTMENT (DOC) HAS UNIQUE AUTHORITY AND A BROAD MANDATE TO ASSIST U.S. BUSINESS WITH TECHNICAL SUPPORT OF INDUSTRIAL TECHNOLOGY DEVELOPMENT AND COMMERCIALIZATION EFFORTS. ADDITIONAL AUTHORITY FOR HELPING IMPROVE ADVANCED MANUFACTURING TECHNIQUES AND OTHER INDUSTRIAL ACTIVITIES WAS PROVIDED BY THE OMNIBUS TRADE AND COMPETITIVENESS ACT OF 1988 (P.L. 100-418). A PRIMARY TOOL FOR FINANCING AND COORDINATING THESE CIVILIAN TECHNOLOGY DEVELOPMENT EFFORTS IS THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) AND ITS ADVANCED TECHNOLOGY PROGRAM (ATP). AEA URGES CONGRESS TO PROVIDE NIST/ATP WITH THE

NECESSARY FUNDS TO CARRY-OUT ITS IMPORTANT MISSION.

DUAL-USE TECHNOLOGIES, SUCH AS ATV, THAT MEET BOTH CIVILIAN AND MILITARY NEEDS SHOULD BE DEVELOPED UNDER THE AUSPICES OF THE DEFENSE DEPARTMENT/DARPA AND THE COMMERCE DEPARTMENT/NIST IN CONJUNCTION WITH INDUSTRY. PAIRING DARPA'S BUDGET, SPEED, AND TIES TO THE DEFENSE INDUSTRY WITH NIST'S RESPONSIBILITY FOR, AND TIES TO, COMMERCIAL INDUSTRY, WOULD PROVIDE THE FEDERAL SUPPORT INDUSTRY NEEDS TO COMPETE IN THESE CRITICAL TECHNOLOGIES.

INDUSTRY-LED CONSORTIA WITH GOVERNMENT

AEA HAS BEEN WORKING WITH MANY GROUPS, IN PARTICULAR IEEE, UNDER THE LEADERSHIP OF PROFESSORS DAVE STAEIN AND ALAN McADAMS, TO EXPLORE THE ESTABLISHMENT OF A NATIONAL MODEL FOR INDUSTRY-LED CONSORTIA INVOLVING BOTH CIVILIAN AND DEFENSE GOVERNMENT AGENCIES. THIS MODEL CONTAINS THREE KEY ENTITIES. IT BEGINS WITH AN INDUSTRY-LED CONSORTIA OF COMPANIES, AND THEN RECOGNIZES THE CROSS-OVER BETWEEN FEDERAL CIVILIAN AND MILITARY R&D BY INVOLVING BOTH DOD AND DOC (SEE ATTACHMENT 4).

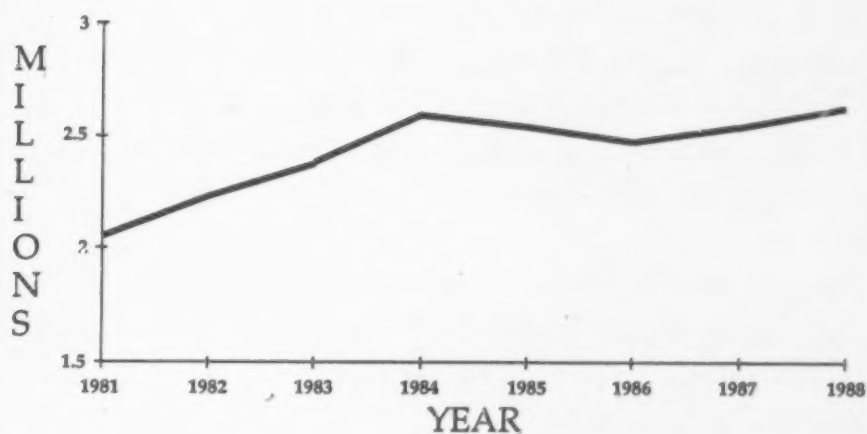
CONGRESSIONAL SUPPORT FOR THIS STRUCTURE, THROUGH SUCH ACTIONS AS PROVIDING THE REQUISITE FUNDS FOR DARPA AND NIST, WILL BE CRITICAL TO ITS SUCCESS. IF WE TAKE THIS MODEL AND APPLY IT TO ATV, WE HAVE AEA'S EFFORT TO DEVELOP THIS INDUSTRY-LED CONSORTIA AND, WITH THE SUPPORT OF CONGRESS, DARPA UNDERWRITING

THE R&D EFFORT AND NIST SPONSORING THE PROTOTYPE MANUFACTURING EFFORT. THE FUNDING OF DUAL-USE TECHNOLOGIES BY BOTH DOD AND DOC CAN MAXIMIZE OUR RESOURCES AND GREATLY BENEFIT OUR ECONOMY AND NATIONAL SECURITY.

DARPA AND NIST COULD IDENTIFY SPECIAL JOINT PROJECTS WITH WHICH TO ADVANCE THEIR SUPPORT OF DUAL-USE INITIATIVES. PERSONNEL COULD BE SUPPLIED BY BOTH AGENCIES, WITH THE BULK OF THE TECHNOLOGY ASSESSMENT AND PROCUREMENTS BEING HANDLED INITIALLY BY DARPA PERSONNEL TRAINED IN THE RAPID FUNDING OF HIGH TECHNOLOGY INITIATIVES. IT IS ENVISIONED THAT DARPA AND NIST WOULD SEPARATELY FUND THEIR RESPECTIVE PROGRAM ELEMENTS. INDUSTRY OVERSIGHT WOULD BE NEEDED TO MONITOR AND DISSEMINATE LESSONS LEARNED BY THIS ENTERPRISE. INDUSTRY OVERSIGHT WOULD BE PARTICULARLY CRITICAL FOR PROVIDING THE GENERAL PROGRAM DIRECTION AND POLICIES, AND WOULD ADVISE THE GOVERNMENT ON THEIR EFFECTIVENESS.

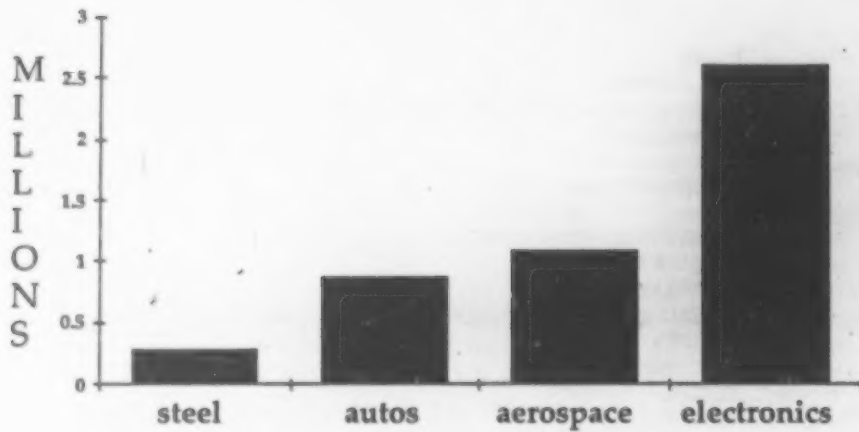
AEA BELIEVES THAT THIS IS A PROMISING MODEL FOR BRINGING INDUSTRY AND GOVERNMENT TOGETHER TO SUCCESSFULLY COMPETE IN THE GLOBAL MARKETPLACE. WE LOOK FORWARD TO WORKING WITH CONGRESS TO PROMOTE SUCH A STRUCTURE.

Largest U.S. manufacturing employer—more than 2.6 million U.S. jobs

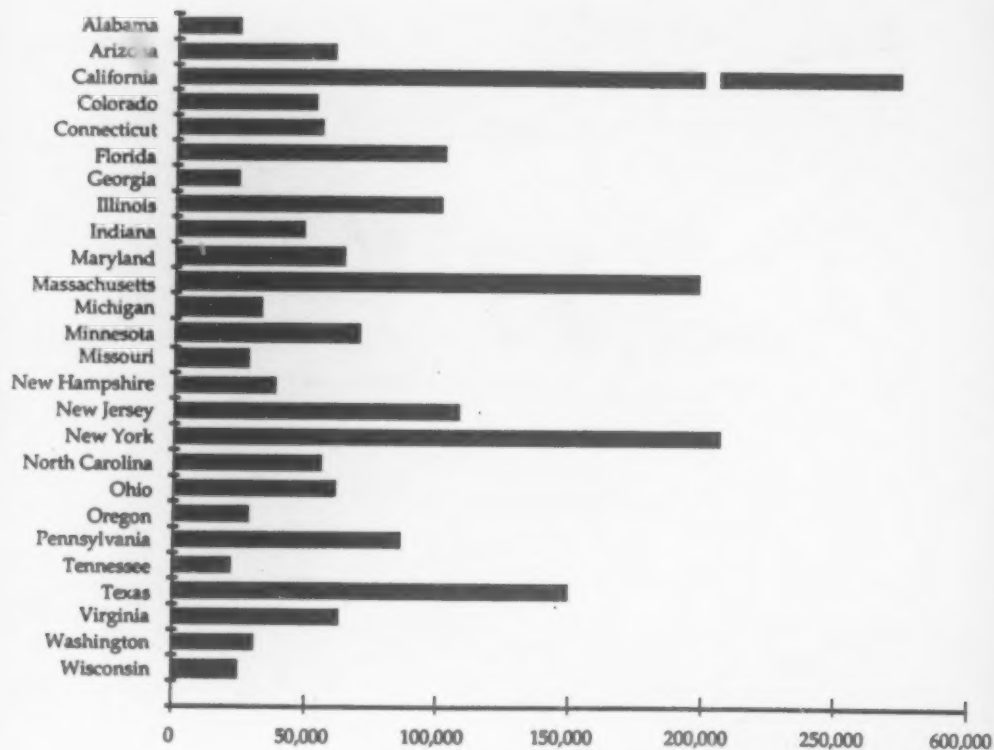


ATTACHMENT 2

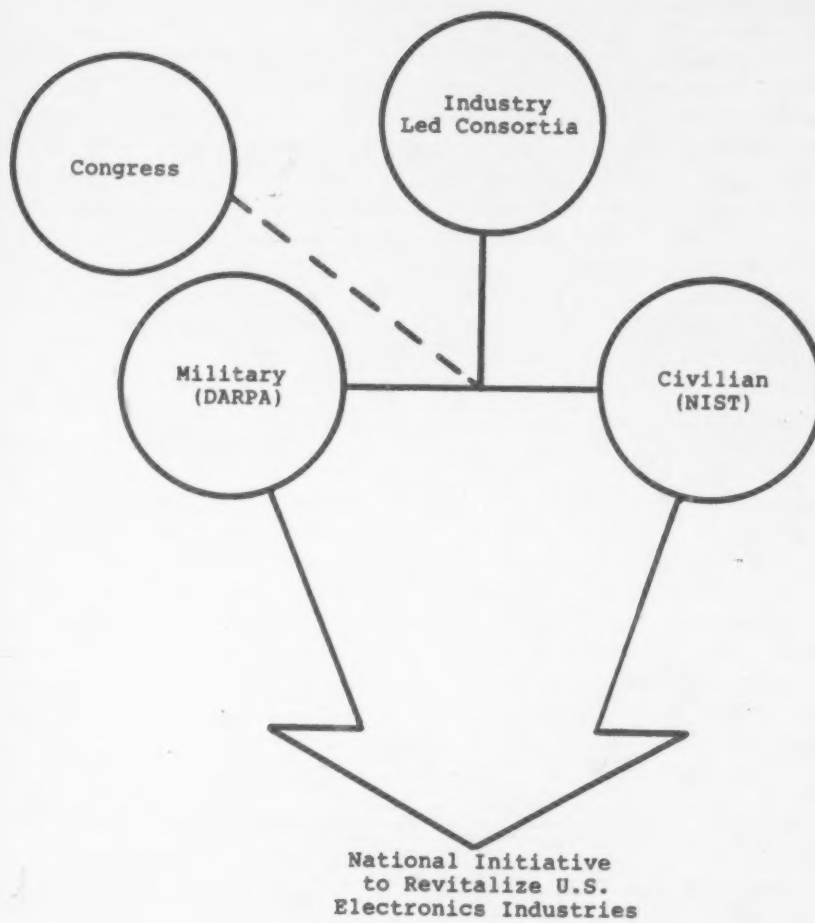
Electronics jobs compared to other industries



Electronics Manufacturing Employment (major states)



ATTACHMENT 4

Industry Led Consortia to Revitalize
The U.S. Electronics Industries

The CHAIRMAN. The Chair recognizes Mr. Jerry Pearlman, President and CEO of Zenith Corporation, Glenview, Illinois.

**STATEMENT OF MR. JERRY PEARLMAN, PRESIDENT AND CEO,
ZENITH CORPORATION, GLENVIEW, ILLINOIS**

Mr. PEARLMAN. Thank you, Mr. Chairman.

I am pleased to share with you the views of Zenith Electronics Corporation on how the United States can be a worldwide leader in high definition television. Dr. Buchsbaum has pointed out that the U.S. is a technological leader in many of the areas required for worldwide success in HDTV, including advanced integrated circuits and video signal compression techniques.

The U.S. is also a leader in the advanced picture tube technology needed for low-cost, high resolution video displays. The U.S. has a great opportunity build on its leadership in these areas and become a major world player in HDTV and high resolution computer displays. We must export the key components, not import them, and we must earn royalties on key technologies and not pay them.

In the HDTV of the future, integrated circuits will represent about 25 percent of the cost, and the display will represent about 50 percent of the cost. That same display is going to represent a significant portion of the computer of the future. The potential swing in trade could be billions of dollars annually.

Translating our advanced computer component technology and TV systems skills into HDTV intellectual property and production leadership will require a supportive national environment. Only the government can remove the longstanding and still prevalent barriers to commercial success and get private investments flowing.

U.S. industry has the technologies needed to succeed; as Dr. Field pointed out this morning, world-leading technologies. Plus, U.S. industry has the ability and desire to commercialize these technologies on its own. The principal barrier that keeps the American companies from making massive new commitments of resources, dollar resources and people resources, to the consumer electronics business is the lack of opportunity for profitability that the market has demonstrated over the past two decades.

Television unit sales in the United States have set new records in each of the last 10 years and for almost every one of the last 20 years, yet U.S. companies have, one by one, closed their doors, locked themselves out, liquidated or sold out at losses because our market became the world's dumping ground for electronic products.

Loopholes in the dumping law and lack of aggressive enforcement have allowed our market to become an incremental volume opportunity for Far Eastern producers with closed home markets; as Secretary Sikes said this morning, making super profits at home and looking at our markets incrementally. They have used our market to build up the scale of their plants and push down their costs.

These Far Eastern producers have been willing to operate their U.S. business at fully accounted losses for years. We're not making this up. They have reported those fully accounted losses, year after year, to the ITC when they were collecting data on the industry by

each competitor. Their unrelenting pressure on pricing and profitability drove most of the U.S. companies not only out of R&D; it drove them fully out of business.

We've been fighting this fight pretty much in isolation since 1970. There have been dumping findings since 1970. There have been almost no collections of any dumping penalties. There have been no collections made for any imports since 1980. All of that is still tied up in liquidation, with Zenith suing the Commerce Department to enforce the U.S. law, and all of the court findings in our favor, but the process dragging on year after year at our expense.

Because of Zenith's substantial market share, premium price position, and very low cost base, we have been able to survive, although we were pushed into the red in consumer electronics in 1987. We have continued to invest in R&D, but at a much lower rate than we would have liked. We have invested more than \$60 million in our high resolution computer picture tube technology. It is the only computer resolution color display tube made in the United States.

We have the world's largest patent portfolio on building picture tubes with shadow masks that are placed under tension. Many of the world's leading picture tube manufacturers—that is to say, the non-U.S. manufacturers—agree with us that tension mass technology will be essential to making picture tubes for high definition television sets and for high resolution computer displays.

We are also convinced that sets based on direct-view picture tubes, not projectors based on flat panels or tubes, will have the largest share of the HDTV market. Direct-view picture tubes are the most cost-effective means of building a high resolution computer or TV screen of less than 35 inches in diagonal.

Projection systems based on tubes or flat panel displays cost about the same no matter how large or small you make the image on the screen or the wall, though with a picture tube the smaller you make the screen, the lower the cost. Direct-view picture tubes are the only way to produce high definition TV receivers that will sell for under \$1,000 before the end of the 1990s. Low prices are critical to high industry volume, which in turn is critical to building up our U.S. semiconductor output.

Zenith needs to invest another \$21 million to develop the production technologies that will allow us to upscale our current 14-inch computer display tube to a 20-inch high resolution computer tube and a 30-plus inch HDTV set picture tube at very low cost to the consumer, and low cost is critical.

The payoff on a successful R&D program in this area will be enormous for the consumer and for U.S. industry. We believe that when our new production technology is commercialized, it will reduce the cost of picture tubes by a significant amount, and it will reduce the capital requirements for new facilities by about half.

Let me put that in perspective. Just to convert about 15 percent of the current U.S. industry volume for television sets into HDTV sets with 31-inch picture tubes would require an investment in new picture tube plants in the U.S. or somewhere around the world, of a billion dollars. Our proposed production technology would cut that investment in half.

Zenith has also spent millions of dollars to develop a unique transmission system for HDTV. Our system will allow every current broadcaster to have another channel at his disposal for HDTV broadcasting. As the U.S. converts to a universe of HDTV receivers over the next few decades, more than half of the spectrum now used for television broadcast would be freed up for other uses because consecutive channels could be used for HDTV broadcasting in every market.

We have recently joined with AT&T to refine this transmission system and develop all the key custom microcircuit building blocks needed to produce the HDTV receivers. AT&T has tens of millions of dollars invested in world-leading positions in many of the specialized technologies required for these critical microcircuits. Together, we need to invest another \$23 million to complete this R&D stage.

We are both committed to going forward and Zenith is committed to going forward on the picture tube portion of the R&D effort, but we could go much faster with government support. That is why these two efforts were developed into proposals to DARPA. I am certain that many of the other proposals DARPA received would also proceed much faster with government support.

Let me conclude by summarizing what Zenith believes the government can do to create an environment for rapid and significant commercial investment in HDTV:

1. There should be fair and tough trade law and law must be vigorously enforced. All we need to do is be neutral with the EC.
2. R&D must be supported for multiple years. The \$30 million initially announced by DARPA would only scratch the surface. One hundred million dollars a year for three to four years, matched by equal or greater amounts by industry, is required. I assure you that industry is ready, willing, and able to make these investments.
3. The standard setting process should not be subverted by foreign pressure. The Japanese and Europeans tried to do that by forcing upon us an incompatible broadcast standard for satellite. The FCC blunted that thrust by insisting that any U.S. HDTV transmission system must remain compatible with all existing sets and must use no more than one channel for terrestrial broadcasting. Foreign interests are also aware that wide aspect ratios create advantages for them and disadvantages for U.S. production plants and broadcasters, and they are seeking advantage in the production standards as well. Funding should be earmarked for developing U.S. transmission standard prototypes and for FCC staffing to assure complete and uniform testing.
4. Most of the other changes that would create a more conducive environment for industry investment are covered in the Ritter-Levine bill, H.R. 1267. Besides providing for funding and FCC support, it would modify antitrust and tax codes and encourage and direct relevant government procurements.

In that procurement area, I think that it is important that you should be aware in the near term, the largest high resolution purchase that is going to be made in the world will be the close to \$1.0 billion that will be spent on 31-inch high resolution, picture-tube-based terminals that will go into the FAA air traffic control system in 1992 and 1993.

Incidentally, in the two proposals that were debated long and hard, in both proposals the same Japanese piece of hardware was bid because that was all that was commercially available. We think that the Zenith picture tube technology is expandable in order to actually be able to meet that requirement, but we would really have to hustle to get there by 1992 or 1993.

The opportunity is here. The industry has the technology and the interest, but we must be assured that we will also have an opportunity to capitalize profitably on the major investments that are needed. The government can provide that by creating a supportive environment.

Thank you, Mr. Chairman.

[The prepared statement of Jerry Pearlman follows.]

MARCH 22, 1989

STATEMENT BY
JERRY K. PEARLMAN
CHAIRMAN AND PRESIDENT
ZENITH ELECTRONICS CORPORATION

TO THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

I am pleased to share with you the views of Zenith Electronics Corporation on how the United States can be a worldwide leader in high-definition television (HDTV).

Dr. Solomon Buchsbaum, executive vice president of AT&T Bell Laboratories, has pointed out that the U.S. is a technological leader in many of the areas required for worldwide success in HDTV, including advanced integrated circuits and video signal-compression techniques. The U.S. also is a leader in the advanced picture tube technology needed for low-cost high-resolution video displays.

The U.S. has a great opportunity to build on its leadership in these areas and become a major world player in HDTV and high-resolution computer displays. We must export key components, not import them, and we must earn royalties on key technologies, not pay them. In the HDTV set of the future, integrated circuits will represent about 25 percent of the cost and the display more than 50 percent. The potential swing in trade could be billions of dollars annually.

Translating our computer component technology and TV systems skills into HDTV intellectual property and production leadership will require a supportive national environment. Only the government can remove the long-standing and still-prevalent barriers to commercial success and get private investments flowing.

U.S. industry has the technologies needed to succeed, plus the ability and desire to commercialize them on its own. The principal barrier that keeps American companies from making massive new commitments of resources to the consumer electronics business is the lack of opportunity for profitability that the market has demonstrated for the past two decades.

Television unit sales volume in the United States has set new records in each of the last ten years and for almost every one of the last twenty years. Yet U.S. companies have, one by one, closed their doors, liquidated or sold out at losses because our market became the world's dumping ground for electronic products.

Loopholes in the dumping laws and a lack of aggressive enforcement have allowed our market to become an incremental volume opportunity for Far Eastern producers with closed home markets. They have used our market to build up the scale of their plants and push down their costs. These Far Eastern producers have been willing to operate their U.S. business at fully accounted losses for years (as they have regularly reported to the International Trade Commission). Their unrelenting pressure on pricing and profitability drove most of the U.S. companies not only out of R&D, but out of business.

Because of Zenith's substantial market share, premium price position, and very low cost base, we have been able to survive, although we were pushed into the red in consumer electronics in 1987. We have continued to invest in R&D, but at a much lower rate than we would have liked. We have invested more than \$60 million in our high-resolution computer picture tube technology, and we have the world's largest patent portfolio on building picture tubes with shadow masks under tension. Many of the world's leading picture tube manufacturers agree with us that this revolutionary tension-mask technology will be essential to making picture tubes for HDTV sets.

We also are convinced that sets based on direct-view picture tubes -- and not projectors based on flat panels or tubes -- will have the largest share of the HDTV market, by far. Direct-view picture tubes are the most cost-effective means of building a high-resolution computer or TV screen of less than 35 inches in diagonal. Projection systems based on tubes or flat panel displays cost roughly the same regardless of how large or small you make the image on the screen or on the wall, but with a picture tube, the smaller the screen, the lower the cost. Direct-view picture tubes are the only way to produce HDTV receivers that will sell for under \$1,000 before the end of the 1990s. Low prices are critical to high industry volume, which in turn is critical to building up our U.S. semiconductor output.

-4-

Zenith needs to invest another \$21 million to develop the production technologies that will allow us to upscale our current 14-inch tension-mask computer display tube to 20-inch high-resolution computer uses and 30-inch-plus HDTV sets at very low cost to the consumer.

The payoff on a successful R&D program in this area would be enormous. We believe that when our new production technology is commercialized, it will reduce the cost of the picture tube by significant amounts, and will reduce the capital requirements for new facilities by about half.

Let me put that in perspective. To convert just 15 percent of today's U.S. television industry unit volume to 31-inch HDTV picture tubes, current production technology would require new plant investments of \$1 billion. Our proposed production technology would cut that in half.

Zenith has also spent millions to develop a unique transmission system for HDTV. Our system would allow every current broadcaster to have another channel for HDTV. As the U.S. converts to a universe of HDTV receivers over the next few decades, more than half the spectrum could be freed up for other uses because consecutive channels could be used in each market.

We have recently joined with AT&T to refine this transmission system and to develop all of the key custom microcircuit building blocks needed to produce the HDTV receivers. AT&T has tens of millions of dollars invested and world-leading positions in many of the specialized technologies required for these critical microcircuits. Together we need to invest another \$23 million to complete the R&D stage.

We are committed to going forward on both of these R&D efforts, but we could go much faster with government support. That is why these two efforts were developed into proposals to the Defense Advanced Research Projects Agency (DARPA). I am certain that many of the other 85 proposals DARPA received would also proceed much faster with government support.

Let me conclude by summarizing what Zenith believes the government can do to create an environment for rapid and significant commercial investment in HDTV:

1. There should be fair and tough trade laws, and they must be vigorously enforced.
2. R&D must be supported for multiple years. The \$30 million initially announced by DARPA will only scratch the surface. \$100 million a year for three to four years, matched by an equal or greater amount by industry, is required. I assure you that the industry is ready, willing and able to make these investments.

3. The standard-setting process should not be subverted by foreign pressures. The Japanese and Europeans tried to do that by forcing upon us an incompatible broadcast satellite standard. The FCC blunted that thrust by insisting that any U.S. HDTV transmission system must remain compatible with all existing sets and use no more than one channel for each HDTV broadcast. Foreign interests also are aware that wide aspect ratios create advantages for them and disadvantages for U.S. production plants and broadcasters. Funding should be earmarked for developing U.S. transmission system prototypes and for FCC staffing to assure complete and uniform testing.

4. Most of the other changes that would create a more conducive environment for industry investment are covered in the Ritter/Levine bill, HR1267. Besides providing for funding and FCC support, it would modify antitrust and tax codes, and encourage and direct relevant government procurements. In that last area, you should be aware that, near term, the largest high-resolution display purchase in the world will be close to \$1 billion for 31-inch terminals based on picture tubes that will go into the FAA air traffic control system in 1992 and 1993.

The opportunity is here. U.S. industry has the technologies and the interest, but we must be assured that we also will have an opportunity to capitalize profitably on the major investments that are needed. The government can provide that by creating a supportive environment.

* * *

The CHAIRMAN. Thank you, Mr. Pearlman. Did I understand you say that—I know there were at least two proposals put into the FAA air traffic control system. You say they are not. They are using Japanese—

Mr. PEARLMAN. Both of the proposals had the same video monitor for use by the air traffic—

The CHAIRMAN. You are using the past tense, "had." Are they still planning on using that?

Mr. PEARLMAN. There is only one proposal still pending because the contract was awarded.

The CHAIRMAN. Right. The Hughes one was turned down.

Mr. PEARLMAN. The subcontractor specified a Japanese terminal. We are hopeful that we will be able to work with them and provide a—

The CHAIRMAN. But what I'm trying to get at, the government obviously accepted that particular proposal.

Mr. PEARLMAN. Yes, sir.

The CHAIRMAN. And it includes a Japanese terminal.

Mr. PEARLMAN. Yes, sir.

The CHAIRMAN. Okay. How much of that proposal do you know offhand would be dollar/cents related to the billion- plus dollars for the system?

Mr. PEARLMAN. Oh, the billion dollars that I mentioned is just the terminal. That's just the 31-inch terminal and the electronics that wrap around it. It's a \$3.0 billion total procurement.

The CHAIRMAN. Therefore, already before us—and this is very important to get into the record right now—therefore before us on that major project which we are knowledgeable on from the Public Works Committee point of view, one-third of it at present relates to Japanese terminals.

Mr. PEARLMAN. In a rough way. It may be 25 percent, but it's a big number.

The CHAIRMAN. But it's obvious it's close to a billion dollars.

Mr. PEARLMAN. Yes, sir.

The CHAIRMAN. So that speaks unto itself, does it not?

Mr. PEARLMAN. Yes, sir.

The CHAIRMAN. Is it a done deal or are you still competing?

Mr. PEARLMAN. We hope that we are still competing.

The CHAIRMAN. Well, maybe we should have American terminals on the F-16.

Mr. PEARLMAN. The contractor would very much like to have an American solution. There is not presently an American solution available. We believe we have the technology to get there. We need to commercialize the technology.

The CHAIRMAN. I don't want to deter from the other witnesses. What would you see that would get us there quicker? A very significant point. Investment by the federal government along with Zenith for further research?

Mr. PEARLMAN. We need \$21 million just to prove out the production technology for the picture tube. If DARPA has \$30 million in total, we're going to have difficulty.

The CHAIRMAN. I understand that. But it is very important. I am listening intently to everybody today. And what is important is to get into focus and out front what the significant issues are that

people will relate to. Therefore, what I heard from Mr. Pearlman today, that in the particular area, the FAA air traffic control system as presently before us, for which the taxpayer of the United States is going to pay \$3.0 billion plus when you get into overruns, close to \$1.0 billion is allocated for Japanese terminals.

That's what you said; is that correct?

Mr. PEARLMAN. Yes, sir.

The CHAIRMAN. All right. And we still don't consider the door to be closed, and therefore if we recognize this real up-front issue and we had—that's the question I'm asking you—additional resources, could we compete in your judgment?

Mr. PEARLMAN. Yes, sir; I believe that we could.

The CHAIRMAN. Thank you.

Mr. RITTER. If the Chairman would just yield for a second, I think he has raised an essential point here. It is a feature of this overall policy landscape that to create a market early on, before it gets out into the consumer field, by the federal government making these purchases would be an essential thing to do.

If this is an opening, I think we should get our foot in the door, our body in the door, and hold this door open so that we could conceivably move in with an American product.

Thank you, Mr. Chairman.

The CHAIRMAN. I appreciate that. Again, I don't want to take the time, but I think that the point I must reiterate one more time—in order to be successful—I have listened to some of the dialogue here today, and some of the dialogue goes to the point of view that we in private business can do it better. There are schools of thought, and government will say leave the private sector alone.

In fact, the breakfast we attended this morning, somebody got up and said—I've forgotten the gentleman's name and he's probably going to testify—he went along the line and he was saying, well, if we do this, that, thus, and then private enterprise does it, all of a sudden government will get into it.

I want to ask him when he comes and testifies, what did he mean by that?

You're coming back, as I understand, it's a point we're going to have to make, that some additional resources, if they are done immediately, could have a result. That's what I heard Mr. Pearlman say.

Mr. PEARLMAN. Yes, sir. Time is of the essence, however.

The CHAIRMAN. I didn't miss that.

The Chair recognizes the next distinguished witness, Mr. Brett Kingstone, President of the Fiberview Corporation, from Boulder in the State of Colorado.

Mr. Kingstone.

Mr. KINGSTONE. Thank you, Mr. Chairman.

Mr. Chairman, after that sales pitch for New Jersey by you and Mr. Rosenzweig, I am somewhat at a loss for words.

The CHAIRMAN. I don't know why you don't have a subsidiary in New Jersey.

Mr. KINGSTONE. Well, there's no skiing in New Jersey—

The CHAIRMAN. There is, too.

Mr. KINGSTONE.—that I find adequate, sir.

Mr. RITTER. Water skiing.

Mr. KINGSTONE. Our company is located somewhere between two beautiful Colorado ski slopes. That's my sales pitch for Colorado.

The CHAIRMAN. On that basis, okay.

STATEMENT OF MR. BRETT KINGSTONE, PRESIDENT, FIBERVIEW CORPORATION, BOULDER, COLORADO

Mr. KINGSTONE. My name is Brett Kingstone and I am the president of Fiberview Corporation in Boulder, Colorado. We are somewhat smaller, if you haven't guessed, than Zenith and AT&T. I believe the problems which American industry faces in HDTV development require major innovations from private industry and a fundamental change in government policy.

There are two key points that I would like to make: first, that American business needs a government policy which regulates personal greed but which will not inhibit competitiveness. The second point is we need to encourage the development of innovative ideas which will generate American leadership in critical industries.

Hearing a number of the issues discussed earlier today reminds somewhat of a story one of our machinists told me as we were loading up this crate and ready to ship it to Washington. He said that the President decided to take two years vacation, and he turned over the management of the economy to the Vice President. When he returned two years later, he was shocked to see that inflation had almost completely been erased, the trade deficit had been cut to a fraction of what it was before, there was triple the GNP per capita.

In shock, he said, "Dan, how did you do it?" And he said, "Well, George, it was very easy; but if you don't mind, before I explain, would you lend me a few yen while I go down the street and buy a cup of coffee?"

Basically, I think the issue that we are worried about here today is America falling behind and, in fact, perhaps being overtaken; overtaken technologically and overtaken economically. Unlike others, I do not believe that it is a foregone conclusion that the United States has lost the war in HDTV development before the first battle has been fought.

I truly believe that there are innovative American alternatives which can meet this technological challenge. I will demonstrate one such alternative today on the fiber optic screen behind me.

As a small business person and entrepreneur, I believe that competition creates jobs and not the opposite. An industry and a nation become stronger when the objective is to produce quality products at competitive prices. The spirit of competition has always driven innovative ideas to the marketplace, but we must be able to compete on a global scale.

If our government policy continues to finance protectionism instead of financing development, I believe we will only succeed in weakening our nation's ability to compete.

Let me recommend four examples of policy changes required to improve American long-term technological developments which will check the abuses of greed while not inhibiting competitiveness.

First, leveraged buyouts should be regulated. After a leveraged buyout, financiers often cut R&D budgets and long-term develop-

ment projects to serve their narrow, short-term interests in meeting monthly debt service and boosting quarterly earnings. This is very dangerous for the health of our industries.

Second, antitrust litigation should be abolished. How can we compete if we continue to break up our nation's most competitive businesses while foreign corporations are allowed to grow into giant conglomerates? If the hundreds of millions of dollars spent in antitrust litigation was instead spent on development grants for HDTV research, we might have been in the forefront in this field. In short, government funds are better served to encourage trade, not to restrain it.

Third, the Bell Telephone Company should be allowed to compete in HDTV. I am sure you will hear a lot from Dr. Bellisio and other members of the telecommunications community, the telephone companies, regarding that. But I think this is very important. The importance of this technology to our national economy should be placed ahead of protecting a few private interest groups, and I think the Bell Company should be allowed to compete.

Finally, government should assume a leadership role in certain critical strategic industries such as HDTV and superconductivity which are crucial for our society's growth. Development funds should be repaid to government through a royalty on the gross sales of the resulting technology. I think the government should get paid back if they finance private industry. And development efforts, in order to be effective, should be concentrated in one organization such as DARPA, rather than diffused through many agencies.

In less than one year, the coordinated efforts of Dr. William Glenn, the former research scientist at General Electric, CBS Laboratories, and the New York Institute of Technology, coupled with our creative engineers at Fiberview, have brought the fiber optic innovation to the marketplace in the form of the display screen you see behind me.

Fiberview is ready to produce 6-foot by 8-foot screens for commercial applications. We will be in direct competition with Mitsubishi Diamond Vision and Sony Jumbotron by offering standard resolution fiber optic display screens at less than one-half the cost of these competitors in the stadium, arena, and mass transit markets. This same technology can produce large television screens which will be no more than a few inches thick, that can hang on a wall just like a picture, just like this prototype I am holding in my hand, which is less than two inches thick.

The screen behind me is a standard definition prototype which demonstrates the principal behind the technology. The high definition display that we have proposed for the DARPA program will be 3 feet by 5 feet in size and weigh less than 180 pounds, while maintaining a thickness of less than seven inches. In our lab last week, we were working on something that will be less than three inches.

The screen behind me uses 43,200 30/1000 inch diameter fibers. Our future HDTV screen will use 3,750,000 5/1000 inch diameter fibers. That is 86 times the number of pixels you see right here. This will offer 1,125 lines of resolution on a 3-foot by 5-foot screen, and when compared to the proposed Japanese high definition CRT displays, our screen will be less than one-third the weight and half

the cost, while offering a brighter, higher contrast image which can be viewed over much wider viewing angle.

The screen is entirely plastic and does not emit any heat irradiation. This also provides excellent advantages for military applications. Currently, Unisys Computer Systems Division is assisting us in the development of the military applications of our technology.

In our small company, our goal is to take on the world's TV giants in the hopes of providing an American innovation which will leap over the existing technologies. We have the potential to create thousands of jobs for Americans, and HDTV we believe will be to the current TV industry what the advent of color television was to black and white. It will level the technological playing field for new competitors and new products. We believe that our fiber optic technology will render much of the Japanese and Koreans' lead and investment obsolete.

Incidentally, commenting on earlier testimony, our capital costs for annual production levels of 500,000 units would be less than \$40 million, which is far less than the \$1.0 billion and \$500 million figure mentioned earlier.

Innovative visions helped create our country. Perhaps new ideas developed by America's creative young entrepreneurial companies, working in concert with government and industry, may provide us with the answer for our future in HDTV. I believe that government and industry should start off in the same corner of the ring to effect a victory in this technology. Government policy should not inhibit competitiveness. Instead, it should be a catalyst for innovation to help reestablish American leadership.

The entire world is following the developments in this room and so much is riding on your decisions. Let us help establish the words "made in the U.S.A." as a standard of competitive fact in the world markets. Thank you very much for inviting me to speak before this committee, and I would like to particularly thank my hometown congressman, Mr. Skaggs, and also Congressman Mineta whose leadership I admired while I was a student at Stanford.

I welcome you all to visit our facility in Boulder, Colorado so you can see us put this technology into practice and know that there are some guys still fooling around in their garages that make things happen every once in a while. Thank you again for your time.

[The prepared statement of Brett Kingstone follows.]

FIBERVIEW
CORPORATION

Presentation to:

**U.S. House of Representatives
Committee on Science, Space and Technology**

March 22, 1989

**By: Brett Kingstone
President, Fiberview Corporation**

5717 ARAPAHOE AVE., BLDG. 3 • BOULDER, COLORADO 80303 • (303) 444-3800
TELEX: 4963560 • FAX: USA (303) 444-7298

Good morning. My name is Brett Kingstone. I am the President of Fiberview Corporation in Boulder, Colorado.

I believe the problems which American industry faces in HDTV development require major innovations from private industry and a fundamental change in government policy. There are 2 key points I'd like to make.

Point 1: American business needs a government policy which regulates personal greed but which will not inhibit competitiveness.

Point 2: We need to encourage the development of innovative ideas which will regenerate American leadership in critical industries.

Unlike others, I do not believe it's a foregone conclusion that the United States has lost the war in HDTV development before the first battle has been fought. I truly believe that there are innovative American alternatives which can meet this technological challenge. I will demonstrate one such alternative on the fiber optic screen behind me today.

As a small business person and entrepreneur, I believe that competition creates jobs and not the opposite. An industry and a nation become stronger when the objective is to produce quality products at competitive prices. This spirit of competition has always driven innovative ideas to the marketplace, but we must be able to compete on a global scale.

If our government policy continues to finance protectionism instead of financing development, I believe we will only succeed in weakening our nation's ability to compete.

Let me recommend four examples of policy changes required to improve American long-term technological developments which will check the abuses of greed while not inhibiting competitiveness.

FIRST Leveraged buyouts should be regulated. After a leveraged buyout, financiers often cut R & D budgets and long-term development projects to serve their narrow short-term interests in meeting monthly debt service and boosting quarterly earnings. This is very dangerous for the health of our industries.

SECOND Antitrust litigation should be abolished. How can we compete if we continuously break up our nation's most competitive businesses while foreign corporations are allowed to grow into giant conglomerates? If the hundreds of millions of dollars spent in antitrust litigation were instead spent on development grants for HDTV research, we might have been in the forefront of this field. Government funds are better served to encourage trade - not to restrain it.

THIRD The Bell Telephone Companies should be allowed to compete in HDTV. The importance of this technology to our national economy should be placed ahead of protecting a few private interest groups.

AND

FINALLY Government should assume a leadership role in certain critical strategic industries such as HDTV and super conductivity which are crucial for our society's growth. Development funds should be repaid to government through a royalty on the gross sales of the resulting technology. Development efforts, in order to be effective, should be concentrated in one organization, such as DARPA, rather than diffused throughout many agencies.

In less than one year the coordinated efforts of Dr. William Glenn, the former research scientist at General Electric, CBS Laboratories, and the New York Institute of Technology, coupled with our creative engineers at Fiberview, have brought fiber optic innovation to the marketplace in the form of the display screen you see behind me. Fiberview is ready to produce 6' X 8' screens for commercial applications. We will be in direct competition with Mitsubishi Diamond Vision and Sony Jumbotron by offering standard resolution fiber optic display screens at less than one half the cost of these competitors in the stadium, arena and mass transit markets. This same technology can produce large television screens which will be no more than a few inches thick and can hang on the wall like a picture -- just like this prototype that I'm holding in my hand.

The screen behind me is a standard definition prototype which demonstrates the principal behind the technology. The high definition display that we have proposed for the DARPA program will be 3' X 5' in size and weigh less than 180 pounds while maintaining a thickness of less than 7 inches. The screen behind me uses forty-three thousand, two hundred, thirty-thousandths inch diameter fibers. Our future HDTV screen will use three million, seven hundred fifty thousand, five-thousandths inch diameter fibers. That is 86 times the number of pixels that you see on this screen. This will offer one thousand, one hundred twenty-five lines of resolution in a 3' X 5' screen. When compared to the proposed Japanese high definition CRT based systems, our screen will be less than one third the weight and half the cost while offering a brighter, higher contrast image which can be viewed over a much wider viewing angle. The screen is entirely plastic and does not emit any heat or radiation. This also provides excellent advantages for military applications. Currently Unisys Computer Systems Division is assisting us in the development of military applications of our technology.

In our small company our goal is to take on the world's TV giants in the hopes of providing an American innovation which will leap over the existing technologies. We have the potential to create thousands of jobs for Americans. HDTV will be to the current TV industry what the advent of color television was to black and white. It will level the playing field for new competitors and new products. We believe that our fiber optic

technology will render much of the Japanese and Korean's lead and investment obsolete.

Innovative visions helped create our country. Perhaps new ideas developed by America's creative, young entrepreneurial companies working in concert with government and industry may provide us with the answer for our future in HDTV. I believe that government and industry should start off in the same corner of the ring to effect a victory in this technology. Government policy should not inhibit competitiveness. Instead, it should be a catalyst for technological innovation to help reestablish American leadership.

The entire world is following the developments in this room, so much is riding on your decisions. Let's help establish the words, "made in the U.S.A." as a standard of competitive fact in the world market. Thank you very much for inviting me to speak to this committee. I welcome all of you to visit our facility in Colorado so you can see how we are able to put this technology into practice. Thank you again for your time.

FIBERVIEW

A Pioneer in Fiber Optic Innovation

Fiberview Corporation manufactures fiber optic signage as well as state-of-the-art fiber optic display screens.

Ongoing research and development efforts focus on large fiber optic display screens for military simulators and command centers, stadiums, arenas, and mass transit centers. Fiberview also has experience in cold light delivery systems for military and medical applications.

Fiberview was recently selected by Microelectronics and Computer Technology Corporation, (MCC), as one of thirteen companies to participate in an American consortium approach for the development of high-definition television, HDTV.

The company headquarters and manufacturing facility are located in Boulder, Colorado, 25 miles northwest of Denver. Boulder is also the home of the University of Colorado, which offers an excellent engineering library and research facility.

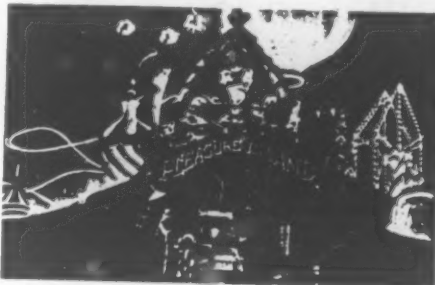
Fiberview Leaders

Mr. Brett Kingstone



Mr. Brett Kingstone, Fiberview President, constructed one of the world's first fiber optic screens in 1980 while he was a student at Stanford University. He produced the largest free-standing fiber optic sign in the world on display at Leisureland's Victoria Park Market in New Zealand. He also produced fiber optic

displays for Disneyland in California and Japan as well as Epcot Center in Florida.



Fiber optic display in Tokyo Disneyland

In March 1989, Mr. Kingstone will testify before the Congressional Committee on Science and Technology regarding American progress on the development of high-definition television, HDTV.

Dr. William Glenn



Dr. William Glenn has served as Director of the New York Institute of Technology, Science and Technology Research Center and Director of Research at CBS Laboratories. He developed the General Electric

Talaria Light Valve and is regarded as one of the world's leading authorities on electronic light source engineering.

Dr. Glenn is also one of the leading American pioneers in the technological development of high-definition television. He serves as Fiberview's patent licensor and provides ongoing consultation as a member of Fiberview's Board of Directors.

HIGH-DEFINITION TV

The Industry Challenge

"As business and government organizations study the various proposals for taping and transmitting high-definition television signals, a major question that remains to be answered is how the new images will be displayed on high-definition receivers. Conventional cathode ray tubes (CRT) built for the typical HDTV receiver, which will have 30 inch and larger screens, will be significantly more bulky, heavy and costly than most sets sold today. An alternative offered by some would be HDTV projection systems for the home. Another would be flat panel displays that could hang on a wall like a picture." --**Broadcasting Magazine**

"The success of high-definition TV may ultimately hinge on yet another innovation--the development of big, cheap flatscreen TV sets that can hang on living room walls like paintings." --**Wall Street Journal**

"All the proposals for high-definition TV are much more attractive when they're shown on wall mounted screens." --**Mr. Robert Wright, President of NBC**

"The differences between conventional TV and HDTV are most striking on big screens of 30 inches or more." --**Business Week**

"If you have been reading the business press recently, you can't have missed the drumroll call for an American industrial policy

to catch up with Japan's lead in high-definition television, or HDTV.

...Far from a revolutionary leap forward, the new Japanese HDTV system is based on current television technology.

...Consultant/author, Peter Drucker, says a competitor should never try to catch up. The goal should instead be to leap ahead, with a new technology. By applying it to television, the U.S. industry can leap ahead of HDTV and leave the Japanese with an empty victory.

...Another important potential advance from the U.S. video industry is the solid-state display system invented by William Glenn of New York Institute of Technology's Research Center in Dania, Fla. Glenn is using fiber optics to create a panel about 3 inches thick; this "screen" is about the size of a large picture frame, and combined with a solid-state internal projector, offers a radically different and far cheaper low-voltage system to display graphics information.

Fiberview Corp., a small technology company in Boulder, Colo., has licensed Glenn's technology. Fiberview President Brett Kingstone believes that within three years the company will be able to produce fiber-based flat displays in mass production quantities for the consumer market." --**Forbes Magazine**

Fiberview Responds

"Our mission is to leap over the existing Cathode Ray Tube and Liquid Crystal Display based technology. We intend to establish a new American technology which will offer a superior product at less than half the cost." --**Brett Kingstone, President of Fiberview**

Fiberview Corporation

FiberView Corporation

FIBER OPTIC DISPLAY SCREENS

SUMMARY OF KEY ADVANTAGES FOR MILITARY ENVIRONMENT

- The fiber optic screen provides a lightweight, thin panel display.
- The fiber optic screen is black. It therefore provides high contrast with high ambient light levels.
- The fiber optic screen provides a wide viewing angle (approximately 180°).
- The fiber optic screen system eliminates the need for rear or front projection. It drastically reduces the projection throw distance and is therefore extremely space efficient. The system is completely self-contained and can be used under all interior lighting conditions.
- Fiber optic screens are shock and shatterproof. They are comprised of 100% hardened plastic.
- The fiber optic screen does not emit ionizing radiation. This reduces the susceptibility to both electronic eavesdropping and interference with other sensitive equipment in land-based and shipboard command centers.

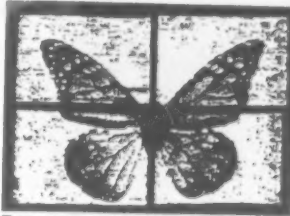
Technology

FiberView: developing fiber optic HDTV receiver

Company hopes technology will lead to resurgence of American manufacturing of television sets

Boulder, Colo.-based FiberView Corp. is developing a technology that it believes will commonly be found in consumers' homes in coming decades. It is developing the prototype of a low-cost flat panel video screen based on fiber optic technology, which it hopes could lead to a resurgence of American manufacturing of TV sets.

As business and government organizations study the various proposals for taping and transmitting high-definition television signals, a major question that remains to be answered is how the new images will be displayed on high-definition receivers. Conventional cathode ray tubes (CRT) built for the typical HDTV receiver, which will have 30-inch and larger screens, will be significantly more bulky, heavy and costly than most sets sold today. An alternative offered by some would be HDTV projection systems for the home. Another would be flat panel displays that could hang on a



First prototype of FiberView's 8 foot by 6 1/2 foot fiber optic TV screen

wall like a picture. But those screens are believed to be about 10 years away from commercial introduction.

FiberView hopes to have a prototype of an industrial screen ready for demonstration in two years. The year-old company is currently developing the display to replace other large-screen technologies, such as the DiamondVision displays sold by Mitsubishi, which are used at sports arenas. It is

also working on a contract with the Defense Department to build high-resolution screens for computer simulators and mobile command centers. Its central project is development of an HDTV fiber optic screen. FiberView is licensed to use techniques invented by William Glenn, director of the New York Institute of Technology's research center in Danbury, Fla. Glenn also sits on FiberView's board of directors.

As it is now envisioned, the standard HDTV screen will be 3 feet by 5 feet, much larger than what is typically provided by a video projection system, according to FiberView President Brett Kingstone. The panel will be three inches deep. The weight of the first prototype demonstrated will be 75-80 pounds, which should be light enough to hang on the wall. Kingstone said, adding: "Of course, the weight will decrease as the technology advances.... When HDTV is actually broadcast in the U.S., we hope to cut the weight by half."

When not in operation, the fiber optic screen will appear black rather than the gray blank screen of a CRT. A black screen, it is believed, improves the contrast quality of the video images. Four-panel modular construction will be used for the standard home receiver. The image on FiberView's first prototype did not reach the ends of the panels, resulting in a black cross in the middle of the display (see picture, above). On the second prototype, now in development, that artifact will be eliminated, Kingstone said. Modular construction will allow the manufacturer to build screens up to any size, he said.

Because a fiber screen uses smaller diameter pixel points, viewers of the large industrial screens now being developed will see a clear picture within a few feet, while other industrial screens must be viewed from several yards. A major flaw with earlier developed fiber optic displays has been unacceptable viewing angles. The good picture is visible if the screen is viewed directly, but color and resolution fade rapidly as one moves to the side of the screen. "We are winding our fibers and slicing it at a certain angle so that you can get an almost 180-degree viewing angle on the horizontal plane.... That is a major breakthrough in fiber optic display," Kingstone said. The viewing angle on the vertical plane will be about 120 degrees, he said.

Other advantages to fiber optic displays, Kingstone claimed, are low power consumption and low maintenance costs. The power consumption of a DiamondVision industrial screen is 20 kw, while the FiberVision screen will be less than 2 kw, he said. Annual maintenance cost of DiamondVision screens is \$70,000 compared to the \$10,000 FiberVision estimates for its screens. Because fiber screens, unlike

*May the
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Health, Happiness & Peace.*

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CRT's, do not emit radiation, they may one day be used for office computer monitors. "Fiber optics only transmit light. They don't transmit radiation," Kingstone said.

The receiver is being built to display 1,125/60 images, in part because that quality will be available to consumers in Japan. Kingstone repeated an earlier statement by Glenn that an ultimate goal of the Fiber-View project is to export TV's to Japan.

Kingstone said that the fiber screen will be competitive with Japanese CRT's for a number of reasons. Estimates of the introductory cost of Japanese HDTV sets have ranged up to \$4,000. A report released last month by the Electronics Industry Association (EIA) predicted that the first advanced TV sets will be sold for \$2,500 (BROADCASTING, Dec. 5). "With a fiber optic light valve and using Dr. Glenn's light valve as our image generator, we project a retail price at \$1,500," Kingstone said. Another advantage, he said, is that the entire manufacturing process is automated and labor will be less than 2% of the price of the product. This will make it easier to set up manufacturing of the screen in the United States, he said.

Fiber technology also compares favorably with other types of flat panel displays, he said. The largest liquid crystal display demonstrated in a lab is about 15 inches diagonally, and most commercially sold LCD's have three-inch screens. There are no inherent limits to the size of gas plasma screens. But laboratory versions with full color have only recently been developed, and none are sold commercially. Kingstone predicted that there will be a market for those displays one day. Fiber will never compete "with liquid crystal or gas plasma for the Watchmans and the small portable home television screens... But high-definition is not small screen. It is large screen," he said.

Experts on video displays contacted last week, including engineers at the EIA, TV manufacturers and others, did not comment on the merits or weaknesses of the Fiber-View plan. Many had heard of the project but did not yet have enough details to assess it. □

The CHAIRMAN. Thank you very much. Does that visit include a ski trip with you?

Mr. KINGSTONE. Sure. You can talk to Congressman Skaggs. He'll arrange it.

The CHAIRMAN. Thank you very much for your testimony.

The Chair recognizes now Mr. Jules A. Bellisio, Division Manager, Digital Signal Processing Research, Bellcore, Livingston, New Jersey.

**STATEMENT OF MR. JULES A. BELLISIO, DIVISION MANAGER,
DIGITAL SIGNAL PROCESSING RESEARCH, BELLCORE, LIVING-
STON, NEW JERSEY**

Mr. BELLISIO. Thank you.

Mr. Chairman and members of the committee, I am pleased to have the opportunity to testify before you today to present Bellcore's views as to the federal government's role in the development of high definition television.

Since 1983, Bellcore has researched HDTV to understand the relationship between HDTV, the future telecommunications network and the services it will transport. While standards bodies will need to address the NTSC compatibility issue and establish appropriate transmission standards, prudent government policy will allow interactive, high-quality HDTV services to be delivered over public, broadband fiber optic networks, with great benefits to business and residential users alike.

Bellcore provides centralized research and technical support to the telephone companies of Ameritech, Bell Atlantic, Bell South, Nynex, Pacific Telesis, Southwestern Bell Corporation, and U.S. West—the regional companies formed by the 1984 divestiture of the Bell System. The mission of Bellcore is to provide technical support and other services that are driven by the needs of its shareholders in providing exchange telecommunications and exchange access services. Bellcore's primary roles are in the areas of network designs and standards. As such, Bellcore is in a position to provide input on the issue of standards and has conducted research on HDTV because of its potential implications for the communications networks necessary for the coming information age.

Now, HDTV represents a revolutionary improvement in visual communications. Bellcore activities tend to be analogous to that carried out previously by the former Bell System, where acoustical research provided the basis for designing the world's finest telephone network. Our HDTV research seeks to establish a body of knowledge from which we may draw conclusions about the far-reaching effects and future directions of such systems. In this regard, Bellcore has established laboratories with cameras, tape recorders, monitors and the like, switching equipment, to study and explain this new technology to national leaders, technologists and the citizenry.

We are studying how to design and build networks for HDTV because we foresee transmitting this signal for a variety of needs, including business applications and entertainment. We especially seek an understanding of how HDTV fits with our view of the networks of the coming decade.

Our vision of the telecommunications environment of the coming decade is information networking, defined as access to information on demand, from anyone to anything, from anywhere to anyplace, and in any volume. We view video as just one information format and HDTV is one of the services made possible by the technologies that support information networking. As such, our design of architecture and associated standards must include the need to carry HDTV signals.

Two major components of information networking include Broadband Integrated Services Digital Network (BISDN) and the Intelligent Network (IN). BISDN will provide a fiber-based standard access and distribution structure that can be capable of providing the highest quality HDTV. The Intelligent Network will provide features which allow customers to control their video service selection in an unprecedented manner.

Bellcore not only contributes to the technical design of such capabilities, but to serve its clients it also ensures through its contributions and leadership that timely, national and international standards support the evolving network.

The possibilities and benefits of such a transport network structure are limitless. As an example, an integrated, interactive network serving the medical community can offer the highest quality video for remote diagnostic capability for cost-effective medical services. We foresee HDTV as having profound implications for business, medicine, education, and society in general.

Over the past year, the industry has been debating vigorously various standards issues relating to HDTV. Substantial discussion has focused on whether a single transmission standard should be adopted for all types of distribution media; that is, terrestrial broadcast, cable, optical fiber, and the like. There are some who advocate a single standard built around a terrestrial broadcast system. This is in our opinion quite shortsighted. It would force viewers to accept a standard that supports the "least common denominator" medium. In the end, viewers will be deprived of the opportunity for better television from other distribution media capable of delivering better quality.

This debate has ignored the business users of HDTV for whom image quality is especially important. It will be counterproductive to restrict them to a single standard based on a medium they will never use. Bellcore has proposed a framework for a standard interface approach to address this issue which is described in the attachment to my testimony which we have submitted.

Now, let me discuss some specific actions. Specific actions that might be taken should include a strong government encouragement to the standards organizations. If timely progress is not observed, we believe the government should intervene through organizing the U.S. participants and orchestrating the more expedient consensus process.

Bellcore is the largest R&D consortium in the United States. It should be recognized that cooperative technical efforts can yield significant successes, as evidenced by the accomplishments in HDTV, by cooperative in research in Europe's Eureka 95 program. We believe that technical expertise in the key areas of HDTV are scarce, and research and development will be particularly expen-

sive. Therefore, in our view, the government should take further steps, such as making the R&D tax credit permanent. There is need for certainty and consistency with respect to tax law, as research projects are often long-range and high-risk.

Additionally, U.S. policy must encourage investment in research and development. There is a need for legislation that would protect certain joint standards related activities from antitrust challenges.

To conclude, Bellcore encourages government support to create a cooperative environment among potential players. We believe that in this fledgling industry, where little U.S. expertise exists, only a cooperative effort will result in a timely, competitive national response.

Thank you.

[The prepared statement of Jules A. Bellisio follows.]

TESTIMONY
OF
JULES A. BELLISIO
DIVISION MANAGER, DIGITAL SIGNAL PROCESSING RESEARCH
BELLCORE

BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MARCH 22, 1989

TESTIMONY
OF
JULES A. BELLISIO
DIVISION MANAGER, DIGITAL SIGNAL PROCESSING RESEARCH
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Bellcore is to provide technical support and other services that are driven by the needs of its shareowners in providing exchange telecommunications and exchange-access services. Bellcore's primary roles are in the areas of network designs and standards. As such, Bellcore is in a position to provide input on the issue of standards. From its formation in 1984, Bellcore has conducted research on HDTV because of its potential implications for the communications networks necessary for the coming information age.

HDTV represents a revolutionary improvement in visual communication. Bellcore activities tend to be analogous to that carried on previously by the former Bell System where acoustical research provided the basis for designing the world's finest telephone network. Our HDTV research seeks to establish a body of knowledge from which we may draw conclusions about the far reaching effects and future directions of such systems. In this regard, Bellcore has established laboratories with cameras, tape recorders, monitors and switching equipment to study and explain this new technology to national leaders, technologists and the citizenry.

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needs including business applications and entertainment. We especially seek an understanding of how HDTV fits with our view of the networks of the coming decade.

Our vision of the telecommunications environment of the coming decade is "Information Networking", defined as access to information on demand, from anyone to anything, from anywhere to anyplace, in any volume. We view video as just one information format, and HDTV as one of the services made possible by the technologies that support information networking. As such, our design of architectures and associated standards must include the need to carry HDTV signals.

Two major components of Information Networking include Broadband Integrated Services Digital Network (BISDN), and the Intelligent Network (IN). BISDN will provide a fiber based, standard access and distribution structure that can be capable of providing the highest quality HDTV. The Intelligent Network will provide features which will allow customers to control their video service selection in an unprecedented manner. Bellcore not only contributes to the technical design of such capabilities, but to serve its clients it also ensures through its contributions and leadership, that timely national and international standards

support the evolving network.

The possibilities and benefits of such a transport network structure are limitless. As an example, an integrated, interactive network serving the medical community, can offer the highest quality of video for remote diagnostic capability for cost effective medical services. Or educational applications can support great works of art, easily viewed in the classroom. In the advertising industry, the electronic processing of HDTV signals is already replacing the editing of 35mm film as a way to produce printed material because of the very significant productivity improvements, even though such HDTV work stations cost hundreds of thousands of dollars. With video networking, a prospective tourist can take a video stroll through mountain resorts that he or she is considering visiting on vacation. Thus, we foresee HDTV as having profound implications for business, medicine, education and society in general.

In the entertainment area, imagine watching a football game where the clarity and wide picture means you can watch the entire play unfold. Imagine "windows" (subpictures) on the screen that give a close-up of the quarterback, the wide receiver, and the defensive back. Now imagine controlling what you wish to see in close-up. These are just a few of

the services for which we at Bellcore are working on the network control, switching, and transmission capabilities, so that information service providers can offer a wide array of new services to the public.

Over the past year, the industry has been debating vigorously various standards issues relating to HDTV. Substantial discussion has focused on whether a single transmission standard should be adopted for all types of distribution media (terrestrial broadcast, cable, optical fiber, etc.). There are some who advocate a single standard built around a terrestrial broadcast system. This, in our opinion, is shortsighted. It will close the door on innovation and prevent each of the media from realizing its full potential. It would force viewers to accept a standard that supports the "least common denominator" medium. In the end, viewers will be deprived of the opportunity for better television from other distribution media capable of delivering better quality.

This debate has ignored the business users of HDTV for whom image quality is especially important. It will be counterproductive to restrict them to a single standard based on a medium they may never use. Bellcore has proposed a framework for a standard interface approach to address this

issue. See Attachment 1. In our submission to the Systems Subcommittee of the FCC Advisory Committee, we proposed that a standard interface be adopted for all HDTV displays. This will allow each medium to develop optimum transmission solutions and hand off a standard signal to the display. This approach, while not mandating an "intelligent" receiver, allows the consumer to choose the functionality he or she desires in an HDTV receiver. This structure will serve to nurture, not preclude, the delivery of promising HDTV services to its fullest potential as each delivery medium is deployed. Since technology will make possible universal communications highways that many information service providers and consumers can use, it is our hope that our government will encourage rather than impede this benefit to the public.

Specific actions that might be taken should include strong government encouragement to the standards organizations. If timely progress is not observed, we believe the government should intervene through organizing the U.S. participants and orchestrating a more expedient consensus process.

Bellcore is the largest R & D consortium in the US. It should be recognized that cooperative technical efforts can yield significant successes, as evidenced by the accomplish-

ments in HDTV by cooperative research in Europe's Eureka 95 program. We believe that technical expertise in the key areas of HDTV are scarce and research and development will be particularly expensive. Therefore, in our view the government should take further steps such as making the R&D tax credit permanent. There is need for certainty and consistency with respect to tax law as research projects are often long-range and high-risk. U.S. policy must encourage investment in research and development. Additionally, there is need for legislation along the lines of the National Cooperative Research Act that would protect certain joint standards related activities from antitrust challenges. To conclude, Bellcore encourages Government support to create a cooperative environment among potential players. We believe that in this fledgling industry, where little US expertise exists, only a cooperative effort will result in a timely, competitive national response.

Attachment

ADVANCED TELEVISION
SYSTEM MODEL

Indra Paul

Belcore

June 6, 1988

1. Advanced Television System Model

This paper presents a model of the distribution of advanced television (ATV) signals and an analysis based on the model. The model, which is essentially an extension of the ATV system diagram (figure 1) developed in WP4 of the Planning Subcommittee, is broken down into six separate systems for analysis purposes: a production system, a contribution system, a local insertion system, a distribution system, a receiver system, and a display system. Diagrams of the system overview are presented in figures 2 and 3. Each system takes a signal from the previous system, adds to it or changes it, and passes it on to the next system. The functions of each system are described below. The formats of the signals passed across each interface are also described.

1.1 Production System

A production system represents the process of producing the programming that is to be delivered to a viewer. This includes functions such as editing segments, performing special effects, or introducing graphics. This is the main source of the television signal that eventually will be displayed.

1.2 Contribution System

This system represents the high quality links between network studios and between networks and their affiliates. This system should have minimal affect on the source signal.

1.3 Local Insertion

Once the studio signal is received by a local affiliate, the proper local segments are added (e.g., commercials or local public service messages). This represents the final assembly process before the material is distributed.

1.4 Distribution System

The function of a distribution system is to deliver the program from the local studio to a viewer. There are several "media" used for distributing the material: terrestrial broadcast, cable, video tape, video disk, fiber, and satellite (this includes Ku-band, C-band, DBS, and others). Not all of these are currently in use, but they have all been slated for future use. The distribution system has been divided into three functional areas: an encoder system, a modulation system, and the transmission medium. This idea has been illustrated in the detailed system overview in figure 3.

1.4.1 Encoder System

As a subset of the distribution system, the encoder system must compress the ATV signal to allow it to fit within the bandwidth requirements of the distribution channel. A different encoding scheme could be used for each transmission medium (media-dependent encoding), or a single encoding scheme could be used for all of the distribution media (media-independent encoding).

1.4.2 Modulation System

The modulation system takes the output of the encoder system and modulates it for transmission over the distribution medium. Regardless of whether the encoding system is media dependent or independent, the modulation system is media dependent. Each

transmission medium has its own particular requirements. For example, normal terrestrial TV broadcasting uses vestigial sideband AM. Satellites, however, cannot use AM-VSB due to nonlinearity problems, and thus, frequency modulation is used for satellite channels. Also included under the heading "modulation system" is any media-dependent signal conditioning (or processing) that may be performed at the transmission end and/or the receiver end to add robustness to the communications.

1.5 Receiver System

A receiver system must take signals off a particular medium, decode the signals, and pass them to a display device. Functionally, the receiver system is broken down into a demodulation system and a decoder system.

1.5.1 Demodulation System

The role of the demodulation system is to take a signal off the transmission medium and demodulate it down to its baseband form. The method by which a receiver takes a signal off a particular medium depends on that medium. For example, an antenna designed to pick up broadcast frequencies is used for extracting terrestrial broadcast signals, while a light sensitive diode is used for extracting signals from a fiber optic cable. Once the signal is extracted from the medium, it is demodulated. Signals sent over fiber optic cable can be either pulse code modulated and combined via TDM, or frequency modulated and combined via FDM. For signals that are pulse code modulated, the demodulation process involves separating a particular channel from other channels which are time division multiplexed together, and performing a digital to analog conversion. For FM signals, the demodulation process involves separating a particular channel from others which are frequency division multiplexed together and taking the signal off its carrier.

1.5.2 Decoding System

Once the signal is demodulated, it must be decoded. (This is true of NTSC signals as well as ATV signals. For example, with NTSC signals, the color and audio information must be separated from the luminance information and demodulated off their respective subcarriers.) The decoding (as well as the encoding) may or may not be media dependent. That is, a single encoding scheme may be used for all of the distribution media or a different scheme may be used for each distribution medium.

1.6 Display System

After a signal has been received and decoded by a receiver system, it is transmitted to a display system. The display system is responsible for presenting the video information contained in the input signal. Audio and any data capabilities that may be present in future ATV systems are assumed to be included in the category "display system."

2. Interfaces

This section presents a discussion of the signal formats that may appear across the interfaces identified in the system overview (figures 2 and 3).

2.1 Interface A

The signals coming from a production system can take many forms. Currently, the most common signal format used within a studio and across the contribution links is NTSC. There is a trend, however, toward higher quality component (rather than composite) signals. The most probable of these for ATV systems are 1125/60 RGB (or a matrixed combination of these) components or the 22:11:11 (ala CCIR 601) digital component format, although other signal formats may be used as well. This trend toward higher quality signals is to compensate for the degradation that takes place during editing in the local insertion phase (this is true for both NTSC and ATV systems). Thus, the signal is likely to be a member of this family of full bandwidth, component signals.

2.2 Interface B

The signals at interface B can take any of the forms described for interface A, although not necessarily the same. The format of the signal is most likely a function of the equipment connected to the interface. Again, it is important that these signals maintain as much of the original picture quality as possible.

2.3 Interface C

The signals at interface C represent the output of the local insertion phase. Like interface B, this signal is a member of the full bandwidth, component family of signals identified at interface A.

2.4 Interface D1

Interface D1 represents the baseband output of a transmission encoder. (All of the D interfaces are illustrated in figure 3). Of course, the format of the signal depends on the type of encoding that is performed. Some encoding schemes being considered for ATV (e.g., VISTA from NYIT and ACTV II from the David Sarnoff Research Center) will produce two separate signals, while others will produce only one.

2.5 Interface D2

This interface represents the modulated version of the signal present at interface D1. While each modulated signal will be specific to the transmission medium used, there might also be more than one modulation scheme possible for a particular medium. For example, any of the media illustrated could transmit either analog or digital signals.

2.6 Interface D3

The signals at this interface ideally are identical to the signals at interface D2. Of course, there will be noise present as well as other impairments caused by the transmission medium (e.g., due to bandwidth limitations, channel non-linearities, etc.). This is the signal that will reach the home.

2.7 Interface D4

The signal at this interface should be the same as the signal at interface D1. This is the signal that will be input to the decoder in an ATV system. This is also the interface at which an NTSC downconverter, used to convert ATV signals into NTSC signals, might be connected (in the case of an incompatible ATV signal). This interface is not necessary in

current NTSC television sets.

2.8 Interface E

The signal at interface E is the output of the decoder. The format of this signal should be the same for all encoding schemes and distribution media. The ATV display accepts this signal and, with the appropriate processing, presents the information on its screen. Any processing that takes place within the display should be specific to the display itself. It should be independent of the encoding scheme or transmission medium used. Ideally, this signal should have a format similar to the signals across interface A, B, or C. This would imply either an RGB (or some derivation) component format, a TMC or MAC format, or a digital representation of either of these.

3. Explanation of Figures

The following sections describe figures 4 through 8. The system architecture and its implications are examined for each figure. Most of the focus of the following figures is on the distribution system, the receiver system, and the display. In each of the figures, the distribution system has been separated into the components encoder, modulator, and transmission medium. The receiver system is comprised of a demodulator and decoder. Figure 4 shows how the current NTSC system fits within this model. Figures 5 and 6 contrast the media-independent and the media-dependent approaches to encoding broadcast ATV signals. Figures 7 and 8 contrast encoding schemes for ATV that are compatible with current NTSC TV sets with encoding schemes that are incompatible with current NTSC TV sets.

3.1 Current NTSC

Figure 4 displays a model of the current NTSC system. It is assumed in the figure that the signal coming from the local insertion system is in component form, in which case, an NTSC encoder is needed. The NTSC encoder, which is located between interfaces C and D1, converts its input signal to an NTSC standard signal format, i.e., 525 lines, 59.94 fields/sec, and frequency interleaved color and luminance information. The format of the signal input to the NTSC encoder can take many forms (see the previous section covering interface C), but, in general, they are high quality component signals.

A typical NTSC television set is represented in this model as the demodulator, the NTSC decoder, and the NTSC display. Most TV sets have only two inputs, a standard antenna input and, in some cases, a cable input (interface D3). The interfaces D4 and E are usually buried within the cabinet of the television and are inaccessible. While some televisions do have an RGB input (corresponding to interface E), these are usually high priced and represent only a small percentage of the overall market. There are, however, products that take advantage of this interface, as illustrated by the Super-VHS tape player in figure 4.

Presently, tape and disk players modulate the signal received off the tape (or disk) to a frequency appropriate for a terrestrial broadcast signal (channels 3 or 4). This modulated signal is then sent to the antenna input of the TV. The tape (and disk) player, within this model, is represented by the tape (or disk) demodulator and the modulator used to convert the tape (or disk) signals so that they may be sent to the antenna input.

3.2 Media-Dependent and Media-Independent Encoding

Figure 5 represents an ATV system in which a single encoding method is used over all the transmission media. This is represented at interface D1, where the output of the encoder is input to the modulator for each medium. At interface D4, the output of each demodulator is then input to a single decoder. Figure 6 illustrates an ATV system that uses a different encoding scheme for each transmission medium. In this case, interface D1 is media-dependent.

When a single encoding scheme is used for all media, as shown in figure 5, the receiver subsystem is simplified in that only one decoding process is required. In terms of bandwidth, however, the single encoding scheme would need to compress the ATV signals to fit into the *most bandwidth limited transmission channel*. This effectively limits the picture quality available to a consumer, regardless of transmission media, to that which is possible over the weakest transmission link.

The single signal format must be compatible with each of the transmission media that may carry it. This represents a difficult challenge as the different media have different characteristics and constraints. For example, encoding schemes that produce signals in which the color information and luminance information occupy different frequency ranges (e.g., NTSC and compatible schemes) may produce unacceptable artifacts when transmitted over satellite channels. This is due to the triangular shaped noise spectrum that is evident on FM satellite channels. Since the noise is greater at higher frequencies, it will affect color and luminance signals differently. This problem could be averted by using a different encoding scheme for satellite channels. In order to meet the interface to the decoder at interface D4, the encoding scheme of the signal taken off the satellite channel would need to be converted.

Note that, even though figure 5 shows the output of each demodulator going directly into the decoder at interface D4, it is not absolutely necessary that interface D4 be open. Since a single encoding scheme is used for all the media, simply modulating a signal from one media interface to another shouldn't affect the quality of the signal. One example of this, shown in figure 4, is the re-modulation of a signal taken off a tape to meet a terrestrial antenna interface.

In the case of media-dependent encoding schemes, as illustrated in figure 6, the picture quality is a function of the consumer's choice of media and is not constrained by an encoding scheme that must be appropriate for the most bandwidth limited channel. The media-dependent approach allows the full potential of each medium to be realized as compared to the media-independent approach where the picture quality (as measured by information content) is constrained by the weakest transmission link. That is, each encoding scheme (in a media-dependent system) is tailored to a particular transmission medium. It, therefore, can take full advantage of the bandwidth that is available, providing the highest quality signal achievable for the particular medium chosen. Since a different encoding scheme could be used for each medium, the consumer might require several different decoders in order to receive signals over several different transmission media. While this may increase the cost to the consumer, if the display is separate from the receiver and has an input at interface E which is independent of the encoding scheme and the transmission medium, the receivers for the different media (i.e., the demodulators and

decoders) can be added one at a time, at the consumer's choice. It is also true that the decoding will most likely be done using digital IC technology, which, when produced en masse, is relatively inexpensive.

3.3 NTSC Compatible and NTSC Incompatible ATV Systems

Figures 7 and 8 give examples of how ATV terrestrial broadcast signals might be received by current NTSC television sets. A media-independent, NTSC compatible ATV system is shown in figure 7. Since the ATV signals are NTSC compatible, the NTSC receiver can use the signal directly, without any additional processing or conversion. If the ATV signal is incompatible, as shown in figure 8, a separate downconverter used to convert an ATV signal to an NTSC signal and a modulator to modulate the converted signal to a standard terrestrial broadcast frequency would be required. The modulator is required in order to meet interface D3 in the NTSC television set. This is the only interface that is available in most NTSC sets.

Even though figures 7 and 8 only portray a media-independent ATV system, the same principles apply to media-dependent systems. That is, if the ATV media-dependent encoding scheme used over terrestrial broadcast channels is NTSC compatible, then it may be received directly by an NTSC television set. If it is incompatible, additional electronics to convert the ATV signal to a modulated NTSC signal are required. Since the encoding schemes are media-dependent, a different downconverter (and demodulator) may need to be used, e.g., for cable ATV signals and terrestrial broadcast signals. In an ATV system that uses media-independent encoding, the same downconverter may be used for signals received over any medium. Of course, the demodulator must be specific to each medium.

4. Interface Standardization

This section will discuss the consequences of standardizing each interface within the distribution, receiver and display systems identified in the detailed system overview.

The number of signals passing across interface D1 depend on whether the ATV encoding is media-dependent or media-independent. Standardizing these signals entails choosing a single format that will be used over all the transmission media (media-independent system), or selecting a format for each transmission medium (media-dependent system). Regardless of the media-dependent vs media-independent issue, it is technically possible to use several encoding schemes for a particular medium, although choosing a single standard for each medium has obvious economic efficiency and compatibility benefits. The use of a single encoding scheme per medium allows the number of people who are able to receive a particular signal to be maximized. The consumer will also benefit because decoder prices will be lower due to economies of scale that occur when manufacturing to a single standard (per medium). While there are many advantages to using a single encoding scheme per medium, technology is changing so rapidly that an encoding scheme that is optimum for today's environment may become obsolete. Thus, the advantages of having a single standard signal format per medium have to be weighed against the possibility of obsolescence.

The signals across interfaces D2 and D3 are the direct result of the signals over interface D1. If the signals across interface D1 are standardized, then there will be a standard

format per medium across interfaces D2 and D3. In essence, the only parameter that may need to be standardized is the modulation scheme that will be used over a particular medium. The actual signal format is specified at interface D1.

Currently, interfaces D4 and E are buried within most NTSC television sets. With the introduction of ATV and the extra processing that it entails, one or both of these interfaces may need to be opened and standardized. For example, if the encoding is media-dependent, then interface E would need to be open to accept the output of each decoder. Standardizing the signal format across interface E would also be helpful. If interface E were not opened, then the decoded signal coming out of each decoder would have to be re-coded (and perhaps re-modulated) to meet a standard input either at interface D3 or interface D4, much in the same manner that tape and disk players meet the standard terrestrial interface as shown in figure 4. This defeats the primary purpose of media-dependent encoding, which is to allow encoding schemes that are tailored to a specific medium. Another benefit of opening interface E is that it decouples the transmission medium and encoding scheme from the display. This allows changes to the encoding scheme to be made in the future without affecting the display, which represents the majority of the cost to the consumer.

If interface E is open in a media-dependent encoding system, then interface D4 can remain closed. By examining figure 6, it is apparent that the demodulator and decoder may be tightly coupled without affecting the structure of the system. The output of the demodulator/decoder may go directly into the display through interface E. One possible reason for keeping interface D4 open in a media-dependent encoding system is to allow the replacement of just the decoder if the encoding scheme is changed. If interface D4 is not open, then both the decoder and demodulator would need to be replaced. Of course, the manufacturing economics and relative prices of the decoder and demodulator need to be investigated.

In a media-independent encoding system (see figure 5), where there is a single encoding scheme used over all transmission media, the picture quality will not be affected if the decoder remains coupled to the display (i.e., interface E is closed). In fact, picture quality is not affected if interface D4 is closed as well. In this case, the demodulators could not send their outputs directly to the decoder. The outputs will need to be remodulated to meet a standard input (e.g., the terrestrial antenna input) at interface D3. Since this process does not involve any extra encoding, only extra modulating, the resultant picture quality won't be significantly affected. Despite this fact, certain non-TV related applications (e.g., computer systems) may benefit from accessing the display through interface E rather than interface D4 or D3, which require encoded signals. An open interface E also allows changes to be made to the encoding scheme without forcing the consumer to buy a new display.

5. Recommended ATV System Configuration

Based on the previous analysis, two recommendations are made. First, interface E should be standardized. This provides a direct interface to the display, allowing it to be used for purposes other than television (e.g., as a computer monitor) without incurring the limitations imposed by an encoding scheme. The open interface also separates the display,

which accounts for most of the initial cost, from the receiver and decoder. As stated earlier, by making the ATV sets modular, encoding schemes may be updated or changed as needed without forcing consumers to buy a new display. This effectively minimizes the risk of displacing elements of the embedded base associated with a particular encoding scheme.

The second recommendation is that the approach to encoding should be media-dependent. The main advantage to this is that each transmission medium can be utilized to its full extent. Thus, the available picture quality will not be limited by a single encoding scheme that must be tailored to the weakest transmission link (see figure 9) and the consumer will be presented with a much wider range of options.

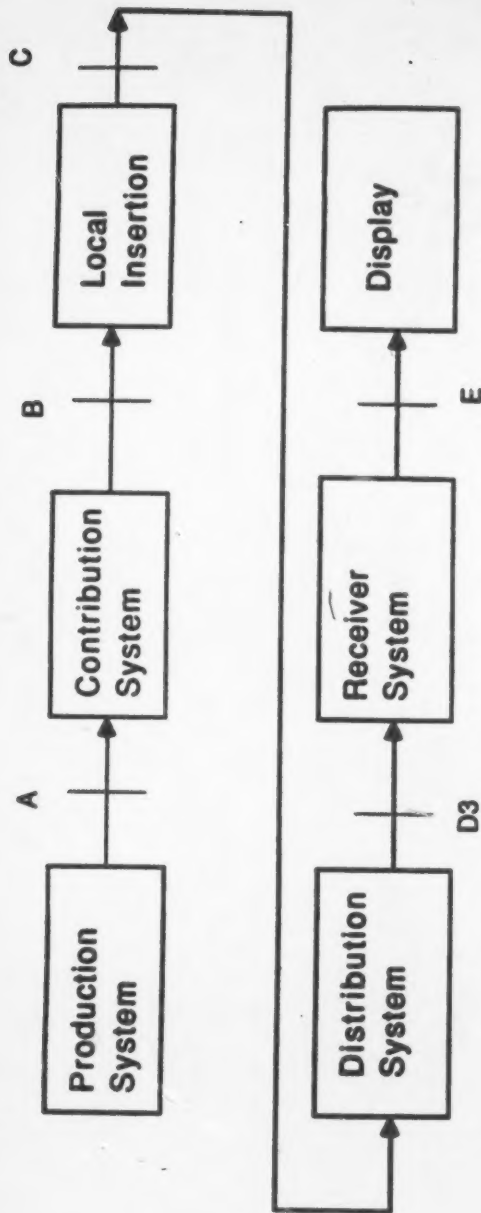


Figure 2 -- System Overview

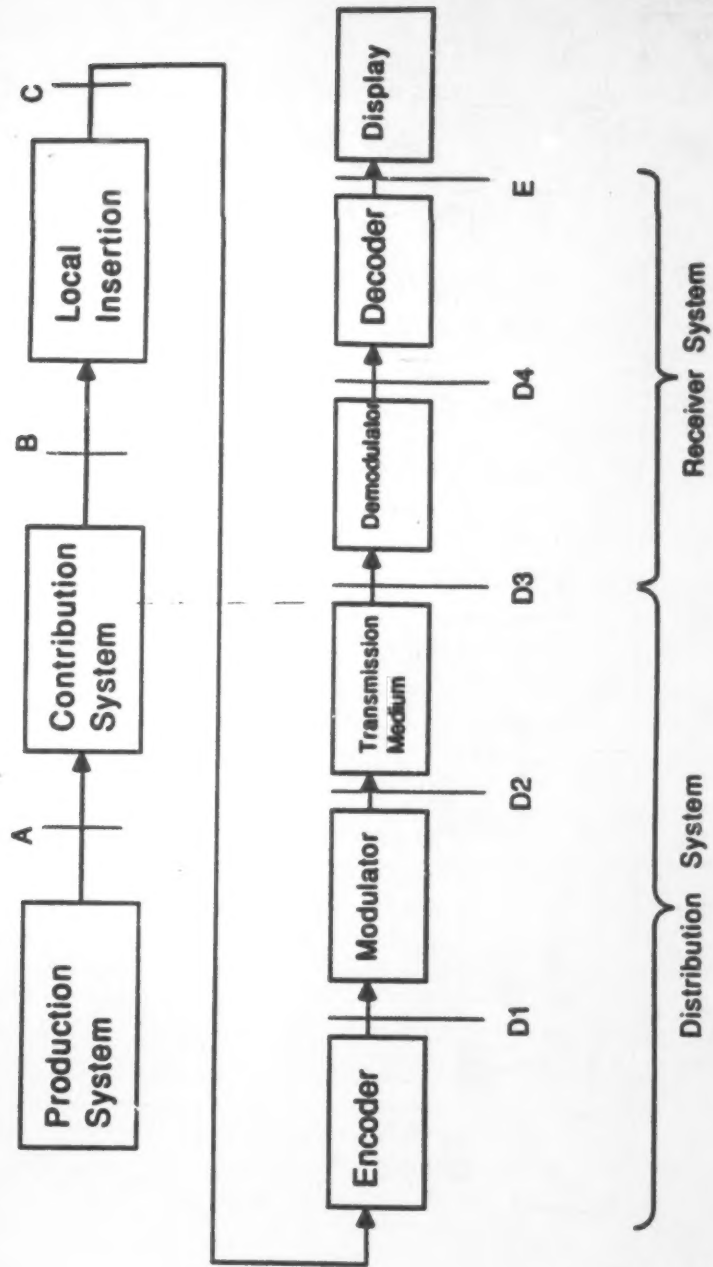


Figure 3 -- Detailed System Overview

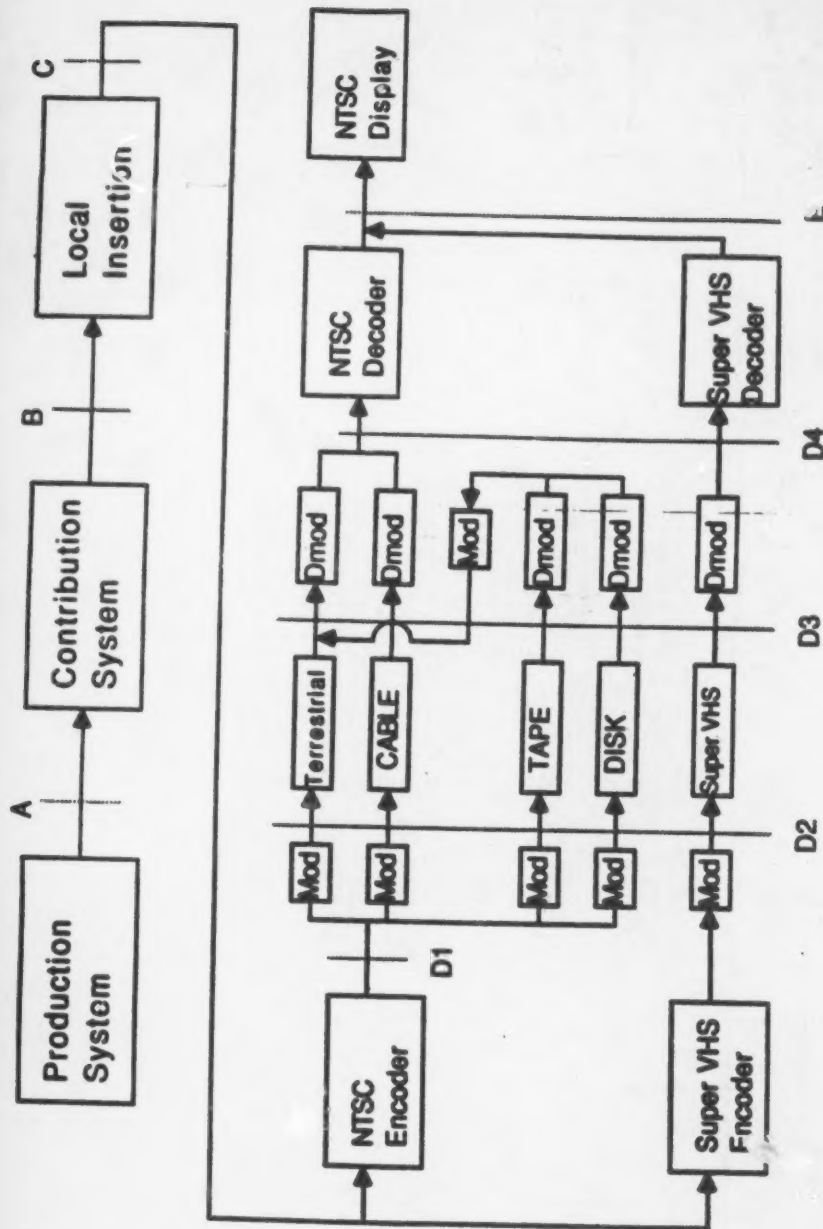


Figure 4 -- Example of Current NTSC System

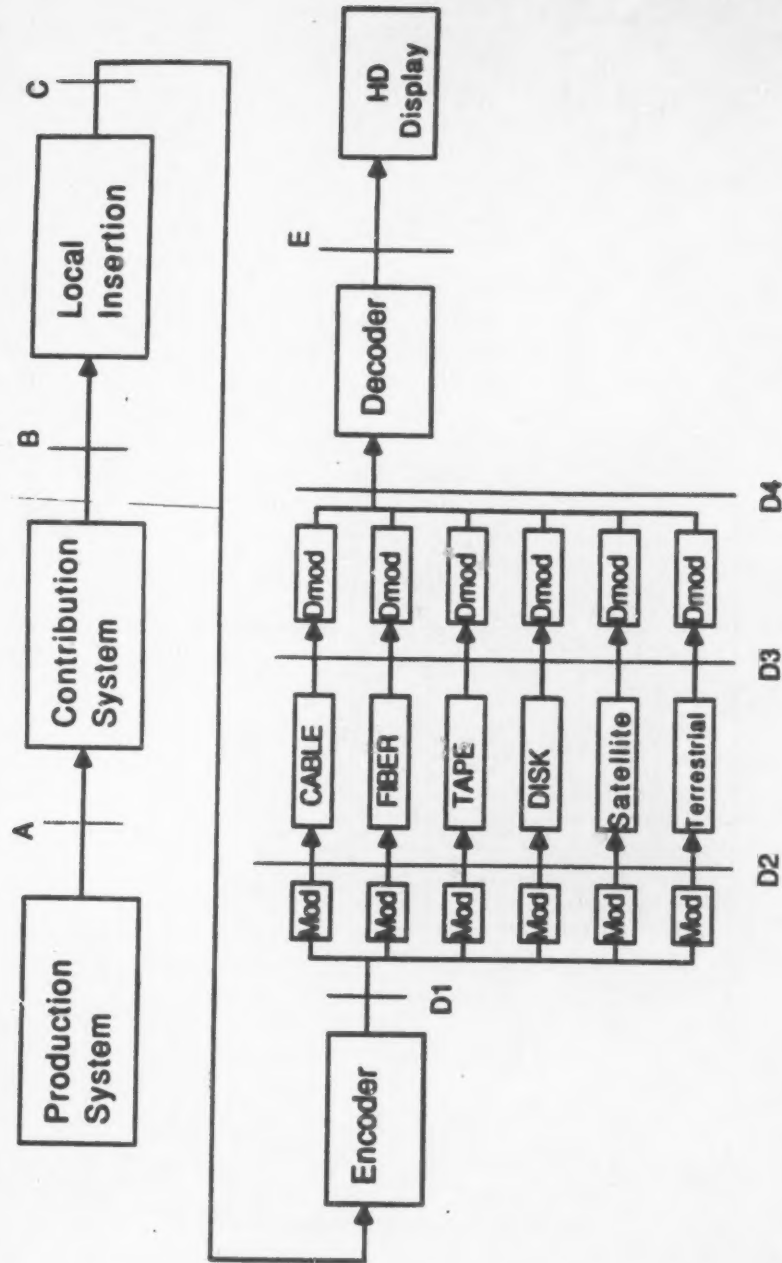


Figure 5 -- Transmission Media-Independent Encoding for ATV

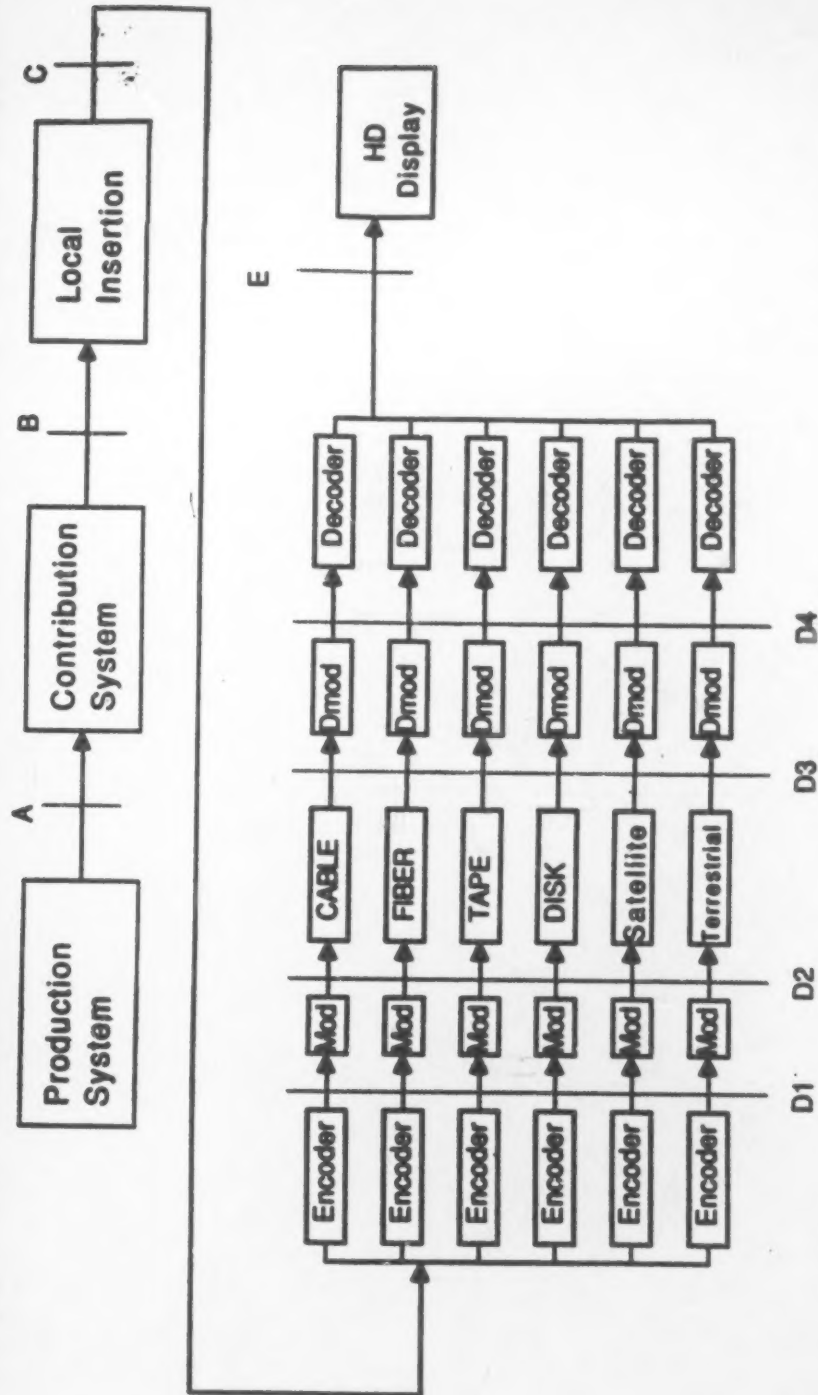


Figure 6 -- Transmission Media-Dependent Encoding for ATV

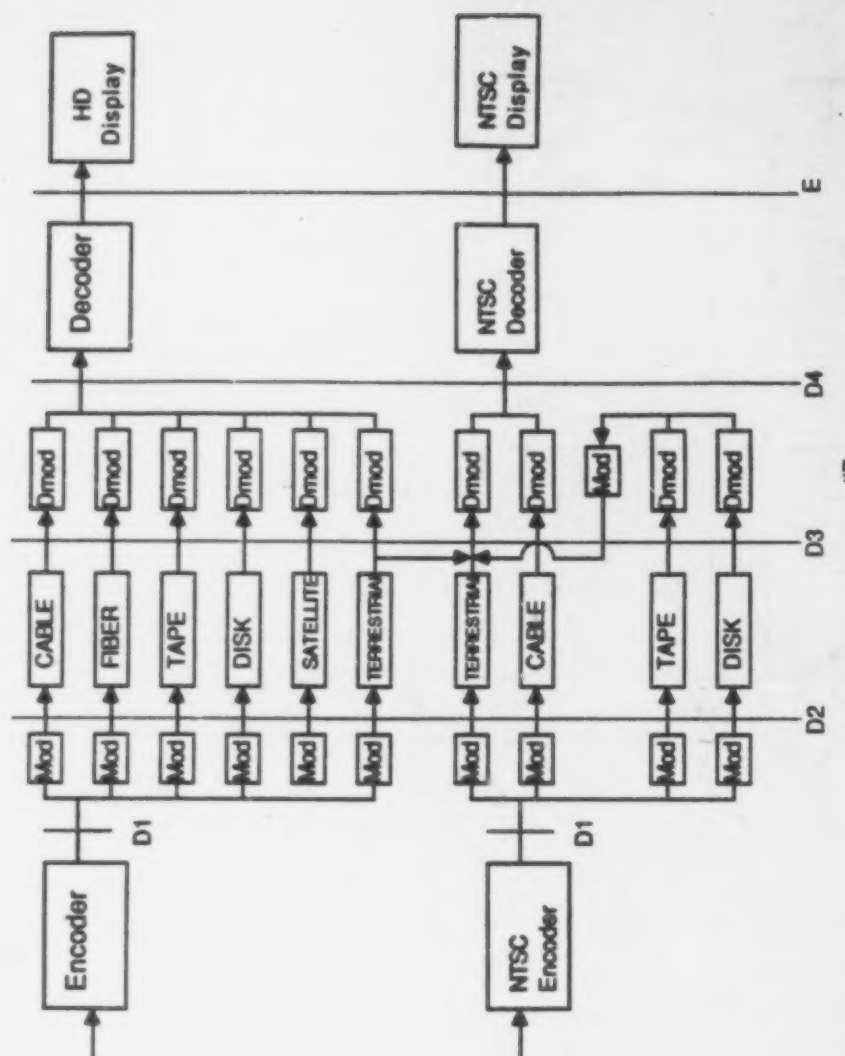


Figure 7 -- NTSC Compatible, Media-Independent ATV System

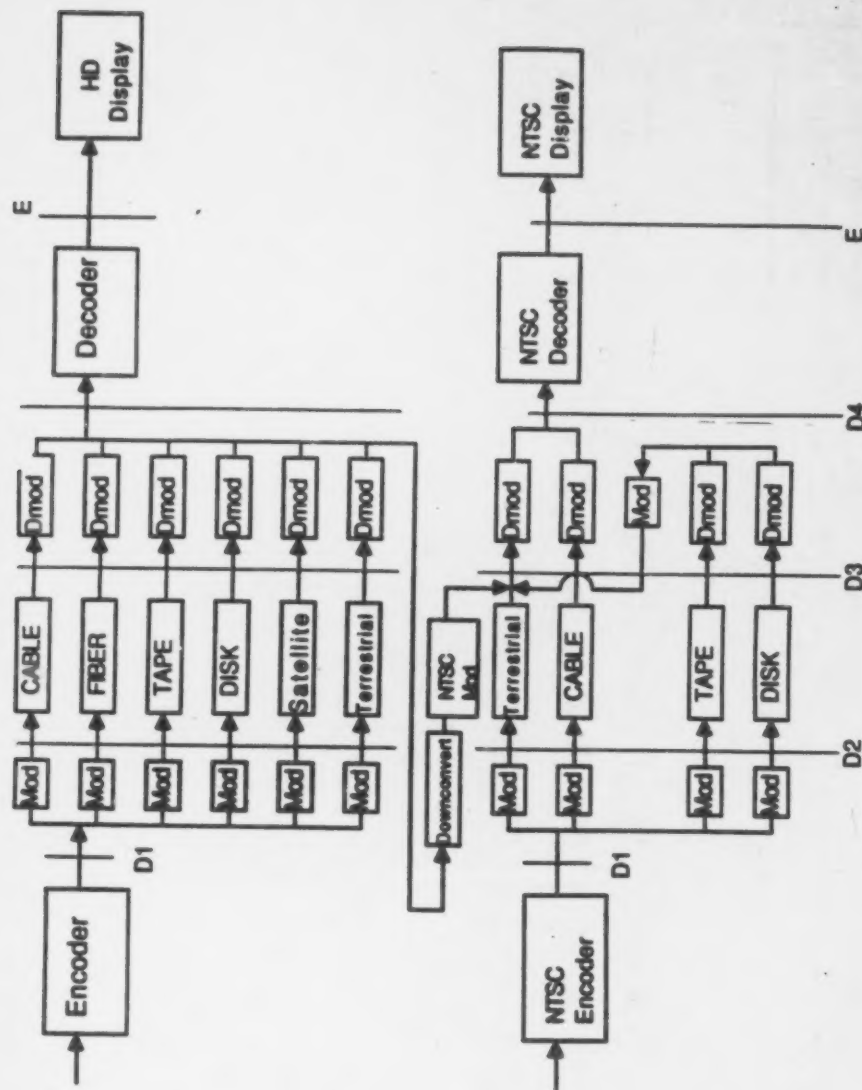


Figure 8 -- NTSC Incompatible, Media-Independent ATV System

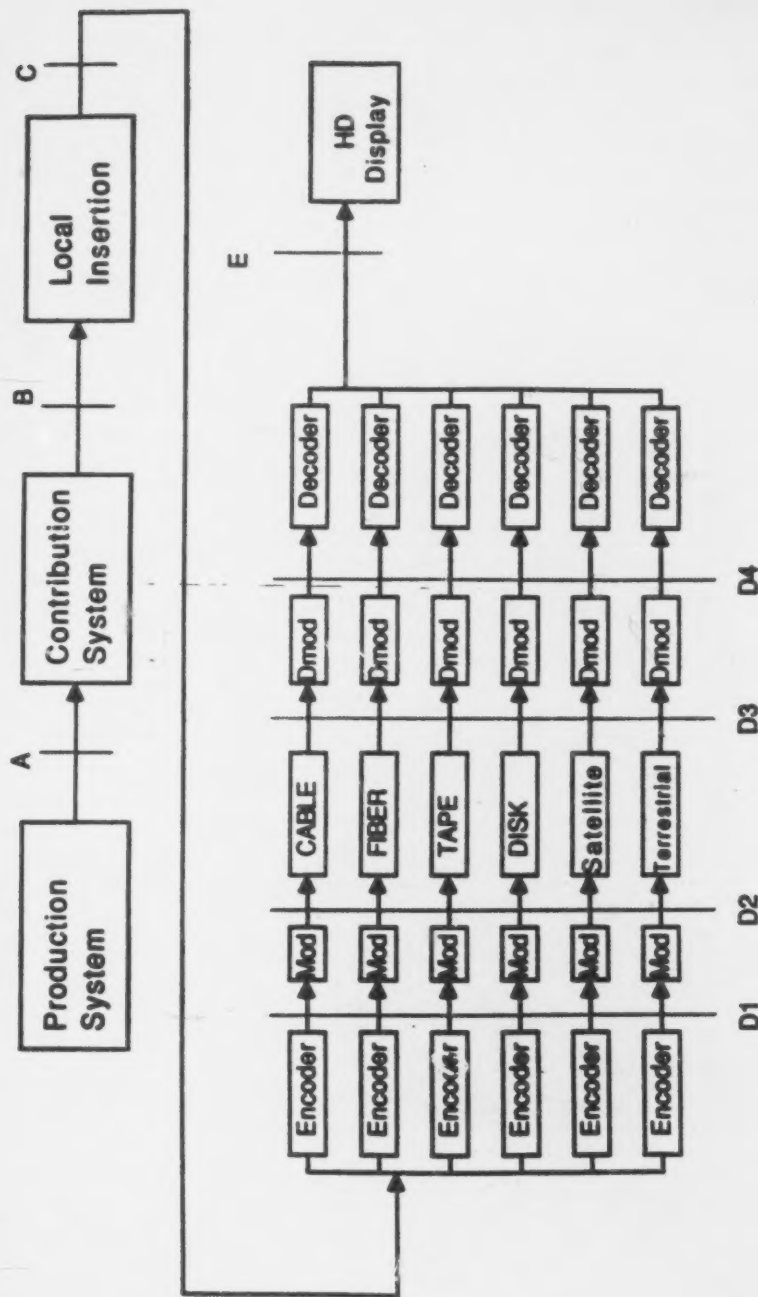


Figure 9 -- Recommended ATV System Configuration

The CHAIRMAN. I thank the gentleman for his testimony. Now for questions, the Chair recognizes the distinguished gentleman from California, Mr. Brown.

Mr. BROWN. Let me deal with just one aspect of this complex situation. Dr. Buchsbaum and Mr. Rosenzweig, you and some of the others have talked about fiber optic cable and their importance to the development of an integrated national network here.

What is the present stage of fiber optic cable in the United States? That is, what percentage of the trunk lines, and how far have we gone in terms of hooking up the ultimate consumers with fiber optic cable?

Dr. BUCHSBAUM. If I could address that question, the AT&T network will be fully digital by 1992, the first year where many people think HDTV will make its appearance. The telephone companies are investing heavily in their plant with an optical fiber capability, bringing it to—in my direct testimony I say “to hubs that are close to home locations, and there are many experiments in New Jersey and elsewhere, bringing the fiber directly to the home.

As you know, Congressman, fiber is a naturally digital medium capable of wideband width, and therefore under certain conditions, not all conditions, is ideally suited for transmission of HDTV signals. So I think the network will not be the impediment. The network will be ready to serve the nation. And by the network, I don't mean just the AT&T network. The totality of all the networks in the United States will be ready to serve the nation if and when called upon to do so for HDTV.

Mr. BROWN. Well, I hope you are right. I have heard some statements to the effect that to provide fiber optic cable to all of the telephone consumers of this country by the telephone companies might take 20 to 30 years. Is that outrageously long or is that reasonable?

Dr. BUCHSBAUM. No, that is not outrageously long, because there are an awful lot of consumers.

Mr. BROWN. And that it would require, of course, an extensive amount of capital investment. The question that I have is: Would it be desirable or possible to speed this up to, say, coincide with the development more closely of the high definition television?

Dr. BUCHSBAUM. It would be possible to speed it up, but the present market pull is not for HDTV; it is for voice data and TV. The telephone companies are beginning to look very seriously into optical fiber for good technical and economic reasons as well.

So there is progress in that direction that I dare say could be stimulated further. I think that there is a provision in Congressman Ritter's bill on how to do that, and that ought to be looked at very seriously.

Mr. BROWN. There seems to be a synergism here. If we want the consumers to have High Definition Television or sophisticated computer transmissions and two-way communication, we need the fiber optic cable. On the other hand, until we get these other things, there isn't a market for the fiber optic cable, and the two need to work together in accordance with some master plan of some sort, it seems to me. Also, of course, there needs to be some way of providing the capital that is required, preferably low cost, but whatever.

Mr. ROSENSWEIG. Let me make one comment on that. Two networks exist in the country today capable of bringing television. One is the Cable Television Networks which have been designed for that purpose, and there certainly is an active program going on right now to begin to put fiber into those networks, although that tends to be an analog, either AM or FM system. And that is the nearer term network that is being fibered, although certainly, the telephone networks are also being done. So there is a longer term digital system for which the infrastructure is going into place, and then there is the Cable Television Systems which are begging to bring cable into their networks. So you have both of those issues going on at the same time.

Mr. BROWN. Well, this raises a issue which we can't resolve here, but to what degree is it desirable from a public policy standpoint to have both cable television and telephones putting fiber optic cable to the consumer? Do we need two systems, two fiber optic systems?

Mr. ROSENSWEIG. It is a free enterprise system.

Mr. BROWN. Elaborate on that a little bit.

Mr. ROSENSWEIG. Well, I mean only that the—you know, when we have a free enterprise system that allows people to invest money where they see business making sense, and those systems do now exist. I guess cable passes about 80 percent of the homes in the United States today, and if they see fit to put cable in to improve service, and they, in fact, can finance that from their revenues, that basically is what the existing system. Television, certainly, is still an analog medium. I think Mr. Pearlman can comment on that more, but you are still bringing in analog signals. I mean, there is a near-term issue and there is a longer-term issue.

Mr. BROWN. What bothers me, though, it is a rather large capital investment to wire every home with fiber optic cable. In the early days of the telephone system when we had competing local telephone companies, it was recognized that this was uneconomic and that it was in the national interest to give a limited monopoly to the telephone company, so that you only had one system and one set of capital expenditures.

Is there a parallel with that today?

Dr. BUCHSBAUM. Let me comment on that just superficially. You are right. On the other hand, today TV is a one-way system. It is all in one direction to the subscriber. The telephone is a two-way system, so they technically demand a different plan, different architectures. One is a star arrangement; one is a parallel arrangement. So long as that distinction remains, and I believe it will remain for a long, long time, the two systems need to be different for economic purposes.

Nevertheless, your point is well-taken. There is a home. My home, or your home needs two fibers or just one fiber to serve both functions. That technical question can be resolved, I believe, in time, with the answer that only one fiber is technically necessary to serve the home. Whether the conditions are going to be right to take advantage of that technical solution, you ladies and gentlemen of this committee will have more to say about it than I.

Mr. BROWN. Well, I don't want to go off on the wrong track on something like this, but when the problem is that we have a shortage of capital in order to expand the necessary broadband commu-

nication system, and we divert that capital to two separate systems, it seems like we are fighting against ourselves when we do that, if one system can serve both needs with suitable protections to both the parties involved. I don't know what that would be, but I think the mind of man could conceive of something. Thank you, Mr. Chairman.

The CHAIRMAN. The Chair recognizes the gentleman from Pennsylvania. No questions. The Chair recognizes the gentleman from Pennsylvania, two Pennsylvanians, Mr. Ritter.

Mr. RITTER. Thank you, Mr. Chairman. With all the good things that have been said about high tech New Jersey, I would like to call attention to high tech Pennsylvania—

[Laughter.]

—and let you know that both Bell Operating Companies and AT&T are extraordinarily active in our State, particularly AT&T, in my own district, has just completed a \$100 million photonics optoelectronics facility called the Solid State Technology Center, which is a marvel to behold, and you are all welcome to come up and visit.

Dr. BUCHSBAUM. May I interject and point out that that is precisely the place where the first transistor was manufactured.

Mr. RITTER. Yes. Allentown, Pennsylvania, manufactured the first transistor, and we recently—that is, AT&T recently, not long ago, removed itself from the emerging semiconductor business because of the kinds of pressures faced from foreign competition.

My question would be, if the fiber network was a real priority, and we wanted to stimulate, for a lot of reasons, not just HDTV, but certainly HDTV would be a big one, and we wanted to stimulate the onset of a fiber network, what policies would we try to change—federal policies would we try to change in order to make this happen faster? It has been said by the operating companies that if they were allowed to do a whole lot of things in contradiction to the modified final judgment which presided over the break-up of AT&T, that we would have fiber faster.

What would be some responses, let's say, from you, Dr. Buchsbaum and you, Dr. Bellisio, could tell us on this?

Dr. BUCHSBAUM. I will defer to Dr. Bellisio first.

Mr. RITTER. Okay. Dr. Bellisio?

Mr. BELLISIO. Of course, the ownership and the operation of the network is a business issue and it is not something that Bellcore deals with directly, but I can give you some technical background, and the technical background says that it is very definitely possible to have a single network that supplies both broadcast type television services and also two-way services. I think that we would be missing a big opportunity, if we designed the new fiber optic network to reach just a new base of HDTV sets without using that opportunity to design a ubiquitous two-way multipurpose communication system.

In terms of what could be done in order to make all of this move faster, right now when we talk about research collaborations, we are talking about collaborations just between organizations that are operating in the precompetitive phase, but the flow of technology is very complicated, and it would be very beneficial if research collaboration could take place not only between research organiza-

tions but also between manufacturing organizations and between all combinations of organizations like that, because while one part of the industry might be in the manufacturing mode, there are other parts that are still in an advanced research mode, and there needs to be a lot of communication. We are restricted from doing that, as I understand, and I think that we would like to see that change.

Mr. RITTER. Dr. Buchsbaum.

Dr. BUCHSBAUM. Well, as I said, I believe that technology will allow, not yet today, but will allow in the future, a single fiber to the home to serve both types of needs that exist today and will evolve in the future. Right now the local telephone companies and the cable TV companies, I believe, have legal restrictions on them on how to serve that market. If Congress removes those restrictions and enables those two industries to work together in partnership, I think you will see much of that happening. Because, as Congressman Brown pointed out, the investment necessary is really huge, and there is no point in duplication.

Mr. RITTER. I mean, you do have the spectacle of Bell Operating Companies investing in businesses that are quite far from the central product line—real estate and a variety of retail business, and the like. But you know, I think—the reason I ask the question is because the policy discussion here goes even deeper than the one we have broached here in this committee and even the one that I broached in my bill, because it does go to what is the future of telecommunications policy regarding the Bell Operating Companies and their competition.

If we put in \$500 million over five years, how much private sector effort do you think that could leverage. And if we had some of these other, more climatological factors taken care of as well, the antitrust factor, the potential guarantee of an initial market factor, the FAA types of purchases factor, how much private sector money could be leveraged, and in the absence of such a stimulus with such environmental modifications, how much could we expect? Just how important is the federal role in actually making a surge forward as opposed to dribbling ahead? Do you want to start off?

Dr. BUCHSBAUM. It might be it will be very important. As Dr. Fields alluded to this morning, he was very pleased with what was submitted from the point of view of cost sharing. Of course, to directly answer your question, he didn't divulge any numbers, and I don't know what the numbers are, but I would be surprised if he were as pleased if the cost share was not based on a 50-50 basis. So 50-50, 60-40 is a good rule of thumb. If the government invests only 10 percent of the total investment, then the leverage it wields is not a big one.

On the other hand, the industry cannot just live off government largesse. So a 50-50 type arrangement seems to me to be a reasonable ballpark figure. You put in \$500 million, I think you can expect the industry to put in at least \$500 million.

Mr. RITTER. And what would we get? It is an important question and one my colleague from California and I were discussing this morning. What would we get in the absence of these kind of stimuli?

Dr. BUCHSBAUM. Well, first of all, it will take much, much longer to get to where we are going; we may never get there. What you will get is an appreciation by the industry that the risk has been reduced. So the shareholder, which—after all, the industry invests from the bottom line, the shareholder can be assured that the return is more likely to be forthcoming on that kind of an investment with a pay-off to the government. I agree with one of the witnesses on this panel who said that the government ultimately ought to be repaid in some fashion.

Mr. RITTER. In other words, you might sense a cost-sharing formula that dealt more with a repayable loan mechanism could be a better mechanism than simply a flat-out cost-sharing formula.

Dr. BUCHSBAUM. For example, with the cost of money today being what it is, that is worth an enormous amount to industry.

Mr. RITTER. Yes. Mr. Kingstone, how do you respond to some of these rather large-scale motions of the Federal Government, the large-scale support that could be forthcoming? I mean, you are the American dream entrepreneur. You live between two ski slopes. You are promoting something on the cutting edge. I mean, do you need the Federal Government to be involved in this?

Mr. KINGSTONE. Congressman Ritter, we are going to move forward whether or not there is government funding. That has always been our plan. We started our company, we achieved our financing long before there was any talk about government funding, HDTV or large screen display. So our agenda is to move forward regardless. I do have to state, however, that obviously government support in the terms of development grants, which I believe, personally, should be repaid by industry through royalty on gross sales, would be very advantageous. Not necessarily that I feel we need to be protected or supported, but that would put on the equal keel in terms of what the Japanese have been doing in the MUSE system, as well as the Europeans in the Eureka project. \$500 million is very large, but I would say, compared to what is being done by our competitors overseas, I think we are about achieving the same mark in balancing the scale.

Mr. RITTER. By the way, the company that you are working with, Dr. Bill Glenn's company—

Mr. KINGSTONE. That's correct.

Mr. RITTER.—and the New York Institute of Technology program, would not be here today in the state that it is, if it wasn't for NASA—

Mr. KINGSTONE. That's correct.

Mr. RITTER.—and a program official at NASA having the foresight to keep something alive in the R&D development and the development of hardware, because when you look at it, the only real hardware that has been built in America to date, to some extent, has been the—I mean, in terms of a total system of hardware, has been the Glenn operation, and that was kept alive by NASA and a couple hundred, \$300,000 a year.

I think our committee, by the way, should take some credit there, because it was the NASA program out of this committee that helped a lot.

Mr. KINGSTONE. It was through Dr. Schaefer, I believe, that you supported specifically, and Dr. Glenn is on our board of directors.

At our annual meeting, which was last Saturday, he did mention, in fact, that this committee and particularly your offices have been very helpful in supporting him. Quite frankly, he pointed out a very important point. Dr. Glenn was, in fact, the spark of technology. There would be no fire on that screen about 20 minutes ago, if he didn't keep that spark alive. We appreciate that.

Mr. RITTER. I thank the chairman. I thank the witnesses for their excellent testimony.

The CHAIRMAN. The gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you, Mr. Chairman. Is it Mr. Pearlman from Zenith? What profits did Zenith make last year and how much money did you make in profits last year?

Mr. PEARLMAN. We returned to profitability after three years of losses and made about \$10 million after taxes.

Mr. ROHRABACHER. \$10 million after taxes.

So a \$21 million grant would be pretty substantial.

Mr. PEARLMAN. It is a very significant number. We have a \$1.5 billion computer business that we have created from scratch in the last ten years, which was the large contributor to the profit last year. So our consumer business really was not carrying its own weight last year at all.

Mr. ROHRABACHER. Okay. You said that there is a billion dollar sale coming up to the FAA?

Mr. PEARLMAN. Yes. That is over a period of years, yes.

Mr. ROHRABACHER. Do you think that companies like yours, or I guess yours is the company that produces these screens in the United States now, can produce a product that is competitive with the Japanese, if you are given a chance and in price?

Mr. PEARLMAN. We think that our product outperforms anything on the market in terms of flatness, brightness, contrast resolution, but we do not have the production capability at the present time to build 31-inch diagonal, and that would take us a couple of years of R&D to upscale the production that we have now which is a 14-inch diagonal.

Mr. ROHRABACHER. And the Japanese have that capacity now?

Mr. PEARLMAN. One Japanese company has that capability.

Mr. ROHRABACHER. So what it is is you basically want the FAA to do that would help us make sure that we maintained our competitiveness in this area?

Mr. PEARLMAN. What we would need in order to catch up with that program is rapid funding of our manufacturing process technology program, the one we have already submitted to DARPA, and we may need the FAA to delay slightly a '92 installation to a '93. We believe we could catch up with the train in late '92 or '93.

Mr. ROHRABACHER. So if we delayed it for a year, with this research that is going on, you could come up with a product that would be competitive both in quality and in price with the Japanese.

Mr. PEARLMAN. We think it would be more than competitive in performance and lower in cost.

Mr. ROHRABACHER. Well, so that would be of benefit to the government as well as to the company.

Mr. RITTER. Would the gentleman yield for one second just on that point?

Mr. ROHRABACHER. Sure.

Mr. RITTER. I think he makes an excellent point. Maybe this committee, as a result of this hearing, and certainly the chairman being, I believe, the second ranking member—the ranking member. That's right. He is the majority. After the chairman, the most ranking Democrat on the committee, maybe our committee should send a letter to the FAA asking them to give us an analysis of this buy and what it means, given the new context of our government and our industry's interest in HDTV. So many of these decisions are kind of left over from the past, where we really weren't going ahead.

I yield back to the gentleman.

The CHAIRMAN. If the gentleman from California would yield, we have already written it down, we will look into the matter.

Mr. ROHRABACHER. Thank you, Mr. Chairman.

Just one general question. Whoever would like to kick this back to me. It seems to me that what we are talking about in terms of antitrust laws were laws that were sort of formulated in people's minds back in the time period when technology was totally different, and we lived in a far different world. In fact, when our companies were basically competing in an internal market rather than an international market.

Would you all—or maybe if someone has a comment to make on this concept, that perhaps many of these antitrust laws are not only costly and antiquated but now are basically threatening our economic survival and there should be a whole new view on considering technology and the world we live in to be a whole new look at these antitrust laws.

Does anybody have a comment, or do you just want to leave it at that?

Dr. BUCHSBAUM. ¹I agree with the basic premise on which you based your question. Those antitrust laws have been written for a different era. They are no longer applicable to the modern world. We do not have a domestic economy; we have a global economy. Companies don't compete; countries compete. We need to take note of that and reflect that in modernizing those laws. They are totally antiquated and useless and counterproductive in many respects.

Mr. ROHRABACHER. Does anybody have an idea of how much that is actually costing the United States? What are we talking about?

Dr. BUCHSBAUM. ²I couldn't really quantify that question, but I can tell you it takes—you know, as both Mr. Pearlman and I said,

¹This paragraph should read: Although I can agree with the basic premise on which you based your question, that the antitrust laws have been written for a different era, they are still applicable to the modern world. Now we do not have a domestic economy; we have a global economy. Companies don't compete; countries compete. We need to take note of that and reflect that in modernizing those laws. But they are not totally antiquated, useless or counterproductive in any respect.

²This paragraph should read: I couldn't really quantify that question. I can tell you what it takes. You know, as both Mr. Pearlman and I said, AT&T and Zenith have entered into a partnership. Not that we did it first—at least on my side, and told the lawyers later, to keep us out of jail. But I can tell you, it took some thinking as to what is doable. So if the amount of energy invested in thinking about these things seems enormous, the very fact that these laws exist precludes many companies from doing anything they really ought not to be doing—they don't want to start.

AT&T and Zenith entered into a partnership. We did it first—at least on my side, we told the lawyers later, keep us out of jail. But I can tell you, it took some thinking as to what is doable. So the amount of energy invested in even thinking about these things is enormous, and the very fact that these laws exist preclude many companies from doing what they really think the country ought to be doing, which is, they just don't want to start.

Mr. ROHRBACHER. Thank you very much. Thank you, Mr. Chairman.

Mr. KINGSTONE. One way to quantify that, by the way, is just look at the awesome legal costs spent by the government and private industry in these, you know, mutually antagonistic lawsuits that have stretched—I think the IBM case went for 12 years, and what have you. And I think it was just a better application of resources than these legal fees.

Mr. ROHRBACHER. So if the money that was channeled into legal fees in fighting antitrust cases was channeled instead into research and technology, it would be a much better place; is that right?

Mr. KINGSTONE. We would be a lot further along in basic research; yes.

Mr. ROHRBACHER. Okay. Well, thank you, Mr. Chairman. Thank you.

The CHAIRMAN. I thank the gentleman from California.

Let me make a comment before this panel, which I think we ought to clarify, so we know where we are going here.

You get a feeling back and forth starting in the earlier testimony, particularly Mr. Sikes, the Assistant Secretary, they keep getting this point across, well, it is private enterprise, and private enterprise can do it better. Private enterprise can do it better. And I don't disagree with that from a management point of view, but what you are saying—at least I hear this—the situation we are involved in now, that substantive resources have to be put up front, if we are going to get off the dime.

Is that a fair point to make?

And is it fair to say too on that basis, that in view of the fact that we are still all in favor of private enterprise, but we are not playing that kind of game in global economy?

Is that a fair point to make?

Let me be the devil's advocate. Suppose for the sake of discussion, and we are going to be battling over there in budget function 250 about reducing the budget and the trade deficit and avoiding sequestration of funds, and the priorities where we should go, blah-blah, and the whole bit. Brothers and sisters are going to be coming back on the floor. They are going to say, well, we need more housing. Of course, we do. And we need to improve the highway transportation system, and on and on and on and on. The minute you start getting into the point of view of Science, Space and Technology, which is resources and research, which people can't deal and touch and see—it is not a building, it is not a automobile, it is not a road—immediately, their eyes glaze over and they come back and say, well, too bad, you know, we can cut there, including the space station, including superconductivity, the issues we are working on.

We are trying to get across to them that we have got to be able to use these investments where they are going to do us the most good to create new wealth. That is the point we have been trying to make before. And I consider what Dr. Buchsbaum was saying here, that is new wealth, that is where the real world is going to be. That is where the resources are going to come. And you will pardon my enthusiasm at the moment. That is where the resources are going to come for the quality of life of the American people. I am thinking about, you know, the health program, exacerbation of those costs and the whole bit.

But for some ungodly reason, we just don't seem to see why we should be able to put those resources forward. Now having said that as the devil's advocate, let me ask you this:

What do you see as the antithesis to the situation? Suppose Congress, in its infinite wisdom, decides no, let private enterprise do its thing. We are lucky that DARPA has got some extra money, because that is a defense system, and that is where all the money went in the last eight years, in fair play, and I mean nothing against anybody on it. But if that is all we have, does that slow us down? What does that do? Are we out of the ballgame then? Some people said—and this is a lengthy question. Sikes said, yeah, but we haven't lost the ballgame. We went to the breakfast this morning—well, the ballgame is still there to be won. But it is not going to be there to be won, if you can't get in to play the game.

Is that a wrong observation? Who wants to try that?

Dr. BUCHSBAUM. Direct government support would be very useful, would be very welcome, would be very important.

The CHAIRMAN. Is it useful, welcome and important—forgive me, I don't mean to be rude—or is it essential at this point, if we are to catch up?

Dr. BUCHSBAUM. Let me come back to that question. I think it is more essential that you pay attention to the point Mr. Pearlman made. We have got to create a climate in this country that the industry can be relatively confident—let me go back. I am not afraid of competing against the Japanese, if the competition is fair so they cannot undercut me by practices that are not condoned in this country. The Congress needs to take steps to make sure that that takes place. That is imperative. Without it, there will be no investment. Everything else is icing on the cake. Yes, government by—

The CHAIRMAN. But you've got to clarify that point. You've got to make that point much clearer than you have made it. You are saying everything else is icing on the cake.

Dr. BUCHSBAUM. Everything is—it would be nice to have, but without it, nothing will go.

The CHAIRMAN. Are we saying—and again, if I am fierce, forgive me. Are we saying—and this is nothing new. In fact, I was at your operation, I don't know how many years ago, and we talked about the competitiveness issue when it wasn't even politically chic to do that vis-a-vis the point of view of the antitrust laws which certainly are archaic in this global economy.

Do you think if we just changed those particular laws, that would be basic, and we don't have to have any further government support?

Dr. BUCHSBAUM. Well, you³ need to modify antitrust laws, and you need to put teeth and enforce the existing laws on fair competition with overseas competitors.

Mr. PEARLMAN. Mr. Chairman, I think without funding, we will miss entire segments of industrial participation, but we won't know the ones that we missed.

The CHAIRMAN. If you will all yield a point—I am just brimming over and I can't help it. I may sit here quietly for three hours, but dammit, now I've got something to say.

There is a whole group that want to cut out the space station, and there's a whole group—there's \$2.1 billion this year for the space station, okay? The piranha are circling the space station. So are the sharks. We will knock it out. It is a big area. We don't really need this space station. But they don't listen to themselves, and they don't listen far enough. In the point of view that if you knock out the space station, you do not need the shuttle program at \$600 million a launch. And if you knock out the shuttle program, you don't need the \$3.5 billion program on the advanced motor for the rockets to have a heavier lift capability.

Therefore, you might as well cancel the whole space program, and you can save \$7 billion.

Do you understand where I am trying to come from?

Now the question, then, fundamentally, is, does the United States want to be in space and have the avenues and the achievements that are being made, or do we not want to? Now that is what Congress has to decide.

Now I am an activist. I haven't got 15 years to wait for you guys to determine what you are going to do with HDTV at all. I want to see something done now! Therefore, we have to go to the floor of the House, and we have to say to them the following: In fair play. The Bush administration is up front on their advance, and they are saying, yes, let's put the money in science, space and technology and education. They are also supporting the space program, which I believe we should be supporting for the future of this country. And we are also saying, yes, we should be supporting the superconductor superconductivity program in Texas. And yes, now, should we be putting funding and subsequent funding into this HDTV, which I don't consider a TV program at all. I consider it an absolute possibility, you know, part of the economic foundation and basis of this country.

Mr. PEARLMAN. I think we have sort of a unique proposition. I would join Mr. Kingstone and Mr. Buchsbaum to say, we may be the one group asking for money that says, you know, we think that so much will come out of this, we would like to pay it back. But it shouldn't be, Congressman Ritter, give us loans and we will pay back. That isn't the way you get creative enterprise, because you are going to drill a lot of dry holes. And the guy who took a loan to drill the dry hole has no resources to pay it back. It ought to be paid back out of success. It ought to be a royalty on the final product that is sold, because the guy who is selling the product is the guy who was successful. And you are talking about funding prod-

³Should read: you don't need....

ucts that are really going to get out there and compete, not pre-competitive technology.

The CHAIRMAN. Can I ask just one question before we break up. Go ahead, Mr. Rosensweig, you wanted to respond.

Mr. ROSENSWEIG. This country is rich with technology, and a great deal of the technology has been created through aggressive funding by the government primarily for national security purposes, NASA, DoD. I mean, I often think if the Russians had launched a high definition TV around the world and it was looking down at us, there would be no problem getting all the money you needed to get it, because we would then say it is a national security issue and get on with it. Okay. Unfortunately, nobody has been smart enough to finance them to do that.

But the issue is not technology. The issue is the cost of capital to build the manufacturing plants to do the development and manufacturing and what are the things that drive that issue. I mean, if it is clear that there's markets—I mean, there is lots and lots of capital that is available in this country that is available for investment. They are just not willing to make investments that have the type of risk and the type of long-term payout that appear to be the type of thing that will happen in this issue. I mean, what the venture capital community has done in this country really has been to provide low-cost capital for great ideals that needed commercialization. But at this point, their window tends to be three years, four years, five years, a tops.

I know that I have a capital-intensive business, and with a return that looks like it is maybe, you know, in another three or four or five years, it is very difficult to raise additional funds. The technology is there. We are capable of making lots and lots of things. We can make things for the AT&T network or the Bellcore network or for a direct broadcast satellite of TV or everything. But there has to be funds available to underwrite the development and manufacturing, and I think that is the role of the Department of Commerce, that is the role of NIST, which is what we were talking about, is to take the great ideas, to coalesce them and to turn them into manufacturable product. That is a market-driven issue. Part of that is providing an environment where there can be a return on that investment which is protecting against dumping, and that is obviously critical.

The CHAIRMAN. I don't disagree with anything you have said. If I were king, I would do that tomorrow morning. But that is not what we're faced with here today. We are faced with an important committee that has to make a recommendation to the Congress of the United States. Now we can slough this off. You know, this bill that Don Ritter has put in is a very substantive bill. The bill that Mr. Brown has put in is a very substantive bill, and there is good meat there. That is why we are holding this at full committee level. The Congress is listening to you today, is what I am trying to say, and this committee is a fighting committee. It doesn't sit back and say: The hearing is over; we go away.

But the substance of what we are attempting to do I see to be a little complex, and if you will forgive me for a moment, is that we are talking about changing basic fundamental structure, which I am totally in accord with doing. I am a Democrat; I think Presi-

dent Bush is dead right on the point of view as far as the investment tax credit and as far as the research is concerned. I think he is absolutely correct, see. And I don't care what anybody else says. All right? But where I am coming from is, we have to make a presentation. We are fighting right now for the allocations that are going to be made, which you don't understand, and I don't mean this unkindly, under budget function 250. Without that, we are not even going to be in the ballgame. It isn't going to happen. So we have to be able to decide in the very immediate future, is this worth doing? I am already totally convinced it is worth doing, number one.

Number two. I happen to agree with Mr. Pearlman. I believe him, because he is convincing to me, I know a little bit about it, that if we can go to Public Works and say, you ought to have an immediate oversight hearing on that issue. If there is a billion dollars worth of work there and we are losing it because we are not making investments, we've got to be idiots to begin with. And we ought to do that, okay?

But the third thing, we've got to be able to go, and I have to go to the floor with our colleagues here, including Mr. Ritter, and say, as a result of hearing the business people, the business community and all our research on this, we say we should be allocating \$100 million this year to this program, and we will worry about how we are going to get the antitrust laws passed and so forth and so on. I am not talking about throwing money at the program now. That is not what I am suggesting.

Do you agree with that approach under the circumstances we are faced with?

Dr. BUCHSBAUM. I hope you proceed this way, Mr. Chairman. Just the way you have outlined it.

Let me point out something that may sound trite. A space station is important. The space program is important. Superconducting supercollider is important. All of these things are very important. But this country will not be able to pay for them unless it has a healthy economic infrastructure, because ultimately the taxpayers pay for it. The consumers pay for it. And if we lose businesses of the sort we are talking together, there ain't going to be a space station ten years from now.

The CHAIRMAN. Precisely.

Dr. BUCHSBAUM. So we have got to make sure our economic house is in order, and that is the first priority.

The CHAIRMAN. Well, I am under the impression, as this panel leave us, and we start the next panel, this panel subscribes to the point of view that the United States ought to be investing \$100 million a year in this program to get ourselves back in the running; is that correct?

The panel: Yes, sir.

Mr. RITTER. Mr. Chairman, I just want to commend the panel and just comment on Dr. Buchsbaum's last statement. What we are dealing with here, and it has been used before, I didn't create this term, is a crucial part of the food chain of the economy, and this part of the food chain, if it is not there, is not going to produce food. And it is food that will allow taxpayer expenditures which do not provide an economic return, like the space station and these

other things you mentioned. That is absolutely critical. So when we sell this to our colleagues, I think what we talk about is, this is the economic lifeblood of the next decade and beyond, and if we are not in it, you know, we could still be the best furniture producers in the world, but the high value added of high technology products is here, and we better be with it or else we are going to be in trouble.

Thanks, Mr. Chairman. And I excuse myself from the hearing. I am going up to the White House to talk about some of these things, and I wish I could listen to the next panel which seems to be as fascinating as the previous panel. Thank you, Mr. Chairman.

The CHAIRMAN. Bring back the check!

[Laughter.]

Mr. RITTER. I'll mail it.

The CHAIRMAN. The Chair wants to thank our distinguished panel very much. You have been highly helpful here and very enlightening to all of us. We appreciate your coming very much.

The panel: Thank you, Mr. Chairman.

The CHAIRMAN. Now Panel Three. We have Dr. Russell Neuman, Director of the Communications Research Group, MIT Media Lab, Cambridge, Massachusetts, Mr. John Eastling, President of Liticom Ltd., San Francisco, Mr. John Sie, Senior Vice President, TCI, Denver, Dr. Alan McAdams, School of Management, Cornell University, Ithaca, New York, and Dr. Harold Krall, President, Cardinal Technologies, Inc., Lancaster, Pennsylvania.

The committee wants to welcome Panel Number Three, all the distinguished members that have come long distances to be with us today.

The first witness we would recognize for his presentation would be Dr. Russell Neuman. Dr. Neuman.

STATEMENT OF DR. W. RUSSELL NEUMAN, DIRECTOR, COMMUNICATIONS RESEARCH GROUP, MIT MEDIA LAB, CAMBRIDGE, MASSACHUSETTS

Dr. NEUMAN. Thank you, Mr. Chairman. My name is Russell Neuman, and I direct the Communications Research Group at the MIT Media Lab in Cambridge, Massachusetts.

I appreciate the opportunity to testify today on the critical issue of high resolution systems and American industrial competitiveness. I have time only to summarize my remarks, and I would ask that my full written remarks be put in the record.

The CHAIRMAN. With no objection, so ordered.

Dr. NEUMAN. You will note that I didn't use the term "HDTV" but rather the term "high resolution systems," and I believe behind that terminology lies a key concept and an important opportunity for the United States to leapfrog ahead of the thinking of our competitors in Japan and Europe. In fact, I think our colleagues in Japan have made a critical mistake in their planning and research on HDTV as a stand-alone device rather than as part of an integrated system. The 1125/60 system is an impressive technical achievement, especially for the 1970s when it was originally designed, but I fear that time has passed that system by. The future of television lies in the digital, not the analog domain. The evolution of video will draw on integrated digital systems which

combine two-way voice, two-way still and motion image transmission under the control of the user, not a one-way analog system.

It would be tragic if the United States were to opt out of this field based on a mistaken belief that only TV sets were involved, and that we are already too far behind. Such a decision would be akin to IBM deciding in the 1950s to stick with punch card sorters, because digital computers were an irrelevant and passing fancy. We simply cannot abandon this field to our international competitors.

Why is this an issue that involves the federal government? And that brings us back to the concept of integrated systems. The free market ideology of unfettered capitalism continues to guide our approach to the issues of trade, innovation and competition, but even the free marketers recognize there are some realms where central authority and coordination can play a critical role. To encourage interstate commerce, we establish a common currency for commercial intercourse, federally supported roads for transportation and a tradition of common carriage which benefits the public as a whole.

With Comsat, we recognized that there were some technological innovations whose scale and scope required more than simply private initiatives. It is a tradition which dates back to the establishment of the Radio Corporation of America in the fall of 1919 at the behest of the Navy, which was concerned about the British dominance of the American Marconi Company and the Kingsbury commitment with AT&T in 1913—which both protected the public interest and encouraged AT&T to develop what became the most advanced long distance network in the world.

Sometimes Congress must do more than wait passively for the private sector to work out a solution. The issue of HDTV and integrated high resolution communication systems, in my view, is just such a case.

There are four special conditions which argue for immediate and significant Congressional involvement.

The first is the character of the technology. As I have argued, the next generation of television—and this has been echoed by my predecessors on the previous panels—involves a revolutionary technological change. In order to digitally process video images, what we do, in effect, is put a powerful computer inside a TV set. Once the computer is there, it can do a great deal more than just sharpen the edges and smooth the movement of objects on the screen. The computer/television combination, I argue, has significant ramifications which move beyond broadcasting to involve the fields of telecommunications, computers and publishing. In 1919, the Navy had the vision to recognize that radio technology represented something more than simply marine telegraphy. We need that kind of vision now.

The second special condition is the scale and scope of the enterprise. Electronic communications is the fundamental infrastructure of the information age, a point emphasized in the previous panel and by you, Mr. Chairman. One hundred years ago some might have argued that a national system of roads, rails and canals for interstate commerce would magically spring up under the efforts of marginally financed competing private entrepreneurs. Fortunately,

their voices did not carry the day and our transportation infrastructure is relatively sound.

There is another possibility, I might note, worse than not building this electronic infrastructure, and that is the possibility of getting it built in the United States by our overseas competitors and, perhaps, controlled by them as well.

The third special characteristic of the integrated digital systems is their technological externalities. The design and manufacturing of high resolution imaging systems represents a technological platform of special relevance to numerous industrial sectors. The same display technology as Dr. Fields pointed out earlier today used in a jet fighter is likely to find its way into industrial control systems and ultimately into home electronics.

We need to pay attention, more attention than we have paid thus far, to the dual use of these technologies.

I emphasize this, the symbolic importance of a national initiative. Our colleagues in Europe and Japan are watching the current debate over HDTV standards and high technology trade in the United States with great interest. In Japan, there has been, as you know, a coordinated effort led by NHK involving 11 cooperating electronics companies, an investment of over \$700 million. In Europe, the Eureka, RACE, ESPRIT and Star programs, the investment in just the last few years approaches \$500 million. They have recognized that the stakes are high. I think they would be pleased if we did nothing at all or proposed some small-scale study that would just further delay our participation in this critical field.

What should we do? And let me summarize these briefly. There have been a number of things proposed, a number of them included in the Ritter-Levine bill. Let me run through them quickly.

- 1) Withdraw American support for the NHK-developed 1125/60 HDTV production standard.
- 2) The DARPA initiative for sponsored research in high resolution displays and transmission systems.
- 3) A new industry-government enterprise dedicated to research and development in high resolution systems.
- 4) A funding allocation which would allow NIST's advanced technology program to become active in this area.
- 5) A National Science Foundation initiative for fundamental research in this field.
- 6) A new program supporting pilot and demonstration projects.
- 7) Special tax credits for HDTV-related research.
- 8) Antitrust waivers or other special arrangements for cooperative research in this field.

Mr. Chairman and members of the committee, I feel that each of these eight points that I have outlined are worth pursuing, and that, in fact, a coherent strategy will involve a combination of them. And I would like to comment, briefly, if I may, on the priorities among those suggestions and initiatives.

The most important proposal, in my view, is the joint industry-government enterprise. Both the financial and symbolic support from government will be crucial for building momentum and sustaining critical mass. And the figure that has been mentioned thus far today in the discussions of a range of \$100 million from the gov-

ernment and matching or greater funds from industry, which is roughly the level that SEMATECH has been proceeding, strikes me as a most appropriate level for support. Anything much less than that, as earlier witnesses have indicated, I think, would be sending the wrong message both to our internal private entrepreneurs and to our colleagues in Japan and Europe.

Also some skeptics have been critical of DARPA's involvement. I would be skeptical too if all federal involvement in this area were filtered through the Defense Department, but DARPA's work is likely, and as Dr. Fields indicated this morning, will be highly coordinated with the Department of Commerce and other federal agencies, and I hope the Hill as well, and that their involvement, I think, offers a special strength that we should take advantage of and encourage joint participation.

One other point which I think may be controversial because it contradicts the things said by people on the committee and my fellow witnesses, some observers have emphasized that if we are to proceed, it must be what is called an industry-led strategy. I disagree. I disagree because I think such catch phrases as "industry-led" are misleading. They imply that the government should sit tight until they are told what to do and then only supply the required funding, but not get involved in decisionmaking.

There are, in my judgment, two things wrong with such a scenario. First, there are public interest perspectives and talented leaders from the government side who could and should play an important role. And second, there are constraints on the industry players, that is, the American industry players, which dampens their otherwise entrepreneurial energies. Many companies market extensively in Japan and Europe and, as well, have joint projects with companies overseas. If a Congressional initiative defines the scale of a new enterprise in high resolution systems and defines the ground rules for participation, I expect a number of important American companies would participate enthusiastically, but they might hesitate to be the first to propose it. Such a venture is neither government nor industry led. It is a cooperative venture.

One final point. In my view, there is a missing element in the research proposals I have seen thus far, as they focus too narrowly on the technology itself and ignore the economic and psychological ramifications. There seems to be an assumption, the same assumption the Japanese mistakenly have made, that there is a strong pent up demand simply for sharper and wider TV pictures. Our research at MIT indicates that the nature of the demand is conditional and much more complex than originally assumed. Consumer interest in high resolution depends on the nature of the program material, the size of the video screen, the viewing distance from the screen and the expectations of the viewer. Digital television and integrated broadband systems can be much more than just old TV sets with slightly sharper pictures.

Therein lies the opportunity for an American initiative of vision to move out ahead of our competitor in Europe and Japan.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Neuman follows.]

Testimony of
Dr. W. Russell Neuman,
Director, Communications Research Group
The Media Laboratory
Massachusetts Institute of Technology
Cambridge Massachusetts

Before the
Committee on Science, Space and Technology
United States House of Representatives

Hearings on
Advanced Television Systems
March 22, 1989

My name is Russell Neuman. I direct the Communications Research Group at the MIT Media Laboratory in Cambridge Massachusetts. Chairman Roe and Members of the Committee, I appreciate the opportunity to testify today on the critical issue of high resolution systems and American industrial competitiveness.

I expect many of you may recall the 1960s movie, The Graduate. There was a particularly memorable scene in the movie when Dustin Hoffman was trying to escape from a boring cocktail party. He was pulled aside by a well-meaning elder who had one single word of advice for this earnest young man setting out on a career in the 1960s. "Plastics" he said. It was a laugh line and most audiences responded appropriately. But for industrial innovation in consumer goods for that era, plastics is as good a watch word as any. If The Graduate were filmed in the early 1980s, the young hero would be pulled aside and, no doubt, the word "computers" would have been whispered into his ear. Computers, especially the explosive growth of free-standing individually controlled microcomputers, represented the watchword of the 1980s.

As we enter the 1990s, it is time for The Graduate, Part III. Now Dustin Hoffman plays the role of the elder advisor. The young hero, Tom Cruise, no doubt, is pulled aside at the cocktail party. What does Dustin Hoffman whisper in his ear? What is the watchword of industrial innovation for the coming decade? Dustin whispers: "Integrated Systems."

Integrated Systems may not make for catchy script writing. But it makes for very interesting economics and international trade policy. Please allow me to elaborate.

There is something very different about plastic widgets, or computer widgets and integrated systems. Widgets are individual, free-standing and self-contained things. Our colleagues in the economic sciences have very elaborate theories about how widgets are best made. Free markets with open competition and pressure for innovation make widgets efficiently and competitively. Governments and government agencies are not good at manufacturing widgets, innovating widgets, and often not very good even at regulating private widget manufacturers. So, we are told, keep the government out of the marketplace. Generally, I concur, that is sound advice.

But the evolution of the next stage of technological development raises a new and very difficult challenge. What were once free-standing widgets, videogames, VCRs and computers are evolving into a single, broadband, digital, integrated system. You'll note that in my introductory

remarks I did not use the term HDTV, but rather high resolution systems. I believe behind that terminology lies a key concept, and an important opportunity for the United States to leapfrog ahead of the thinking of our competitors in Japan and in Europe.

In fact, I think our colleagues in Japan have made a critical mistake in their planning and research on HDTV. There is a historical metaphor which appears to be guiding their research and marketing of HDTV. The notion is that in the 1950s and 60s the world moved from a black and white standard for television broadcasting to a color standard. The Japanese researchers at NHK who began their planning of HDTV in the early 1970s under the direction of Dr. Fujio thought that there might be a commercial advantage for Japan in the 1990s if they could take the lead in designing and setting the world standard for the next generation of broadcast television -- a wider and sharper, high-resolution TV picture. And they designed an analog system for satellite transmission. The 1125/60 system is an impressive technical achievement, especially for the 1970s. But I fear that time has passed them by. When they began this work there was only primitive cable television, no pay-per-view, no VCRs, no videogames, no personal computers, and only the beginnings of digital processing of video signals.

The future of television lies in the digital not the analog domain. The evolution of video will draw on integrated digital systems which combine two-way voice, two-way still and motion image transmission, under the control of the user. The economics of electronic information and entertainment publishing are already changing rapidly. One can buy a book, a musical recording or a movie on a laser disk. Or, in experimental systems, the text graphics or video can be delivered on demand by optical fiber. The fundamental electronics, the chip sets, the coding algorithms and the display devices for computers, work stations and TVs are becoming one and the same. It is the technological platform for the next generation of industrial and consumer electronics. It would be tragic if the United States were to opt out of this field based on the mistaken belief that only TV sets are involved and that we are already too far behind. Such a decision would be akin to IBM deciding in the 1950s that punched card sorters were the wave of the future and that digital computers were an irrelevant passing fancy. We simply cannot abandon this field to our international competitors.

But why is this an issue which involves the federal government? That brings us back to the concept of integrated systems. The free market ideology of unfettered capitalism continues to guide our approach to the issues of trade, innovation and competition. But even the free marketeers recognize there are some realms in which central authority

and coordination can play a critical role. To encourage interstate commerce we establish a common currency for commercial intercourse, federally supported roads for transportation, and a tradition of common carriage which benefits the public as a whole. With Comsat, we recognized that there were some technological innovations whose scale and scope required more than simply private initiatives. It is a tradition which dates back to the establishment of the Radio Corporation of America in 1919 at the behest of the Navy which was concerned about British dominance of the American Marconi Company, and the Kingsbury Commitment with AT&T in 1913 which both protected the public interest and gave AT&T the green light to build the world's most advanced long distance network. Sometimes Congress must do more than wait passively for the private sector to work out a solution. The issue of HDTV and integrated high resolution communications systems is just such a case.

There are, in my judgment, four special conditions in this case, which argue for immediate and significant Congressional involvement:

- 1) The Character of the Technology. The next generation of television and high resolution imaging systems represents a revolutionary technological change. In order to digitally process video images what we do, in effect, is put a powerful computer inside a TV set. Once the computer is there it can do a great deal more than just sharpen the edges and smooth the movement of objects on the screen. The computer-television combination, I argue, has significant ramifications which move beyond broadcasting to involve the fields of telecommunications, computers and publishing. In 1919 the Navy had the vision to recognize that radio technology represented something more than simply marine telegraphy. We need that kind of vision now.

- 2) The Scale and Scope of the Enterprise. Electronic communication is the fundamental economic infrastructure of the information age. One hundred years ago some might have argued that a national system of roads, rails and canals for interstate commerce would magically spring up out of the efforts of marginally financed, competing, private entrepreneurs. Fortunately, their voices did not carry the day and our transportation infrastructure is relatively sound. There is another possibility, I might note, worse than not building this electronic infrastructure. That possibility is watching it get built in the United States by our overseas competitors and perhaps controlled by them as well.

If we are to succeed in generating a conducive industrial climate for moving ahead of our competitors in Japan and Europe in this area, it will require the coordinated participation of the Departments of State,

Defense, Justice and Commerce as well as the FCC. On the industrial side it will require cooperative efforts involving publishing, broadcasting, cable, telecommunications and manufacturing in computers, communications and consumer electronics.

3) The Technical Externalities. The design and manufacturing of high resolution imaging systems represents a technological platform of relevance to numerous industrial sectors. The same display technology used in a jet fighter cockpit, is likely to find its way into industrial control systems, and ultimately into home electronics. Until recently we have paid very little attention to the "dual-use" question, that is, the successful development of civilian applications which consciously take advantage of our superiority in military R&D. We can no longer afford to be so casual about how our substantial national investment in defense technology is translated into a national economic resource.

4) The Symbolic Importance of a National Initiative. Our colleagues in Europe and Japan are watching the current debate over HDTV standards and high-technology trade with great interest. In Japan there has been, as you know, a coordinated effort led by NHK and involving 11 cooperating electronics companies and an investment of over \$700 million. In Europe, through the RACE and SPRINT programs the investment in just the last few years approaches \$500 million. They have recognized that the stakes are high. I think they will be very pleased if we do nothing at all, or propose some small scale study which would further delay our participation in this critical field.

What Should We Do?

There have been a number of proposals for government and industrial initiatives in this area circulating in Washington over the last few months. They include

- 1) Withdrawing American support from the NHK-developed 1125/60 HDTV production standard.
- 2) DARPA sponsored research for high resolution displays and transmission systems.
- 3) A new industry-government enterprise dedicated to research and development in high resolution systems perhaps along the lines of Sematech, MCC or Comsat.
- 4) A funding allocation to allow NIST's Advanced Technology Program to become active in this area.

- 5) An NSF initiative for fundamental research in this field.
- 6) A new program supporting pilot and demonstration projects
- 7) Special tax credits for HDTV-related research
- 8) Anti-trust waivers for cooperative research in this field.

In my view, each of these ideas is worth pursuing. They are complementary rather than conflicting. I would expect that a successful strategy will draw many of these ideas together.

What Are The Key Priorities?

- ==> The most important proposal in my view is the joint industry-government enterprise. Both financial and symbolic support from government will be crucial for building momentum and sustaining a critical mass. Central industry players like IBM, AT&T and others need to be involved. And there must be a balance of industrial experience across the relevant areas of computers, telecommunications, consumer electronics, broadcasting and publishing.
- ==> Some skeptics have been critical of DARPA's involvement. I'd be skeptical too if all federal involvement in this area were filtered through defense department eyes. But if DARPA's work becomes part of a more broadly based initiative, I feel we should take advantage of their expertise, and their natural concern with maintaining industrial capacity in high technology on shore.
- ==> Some observers have emphasized that if we are to proceed, it must be what they call "an industry-led strategy." I disagree. I think such catch phrases as "industry-led" are misleading. They imply that government should sit tight until they are told what to do, and then when told, supply required funding but not get too involved in decision-making. There are two things wrong with such a scenario. First, there are public interest perspectives and talented leaders from the government side which could and should play an important role. Second, there are constraints on industry players which dampen their otherwise entrepreneurial energies. Many companies market

extensively in Japan and Europe and have joint development projects with companies overseas. If a Congressional initiative defines the scale of a new enterprise in high resolution systems and defines the ground rules for participation, I expect a number of important American companies would participate enthusiastically. But they might hesitate to be the first to propose it. That is neither government nor industry led, it is a cooperative venture.

==> Finally, in my view there is a missing element in the research proposals I have seen thus far. They focus too narrowly on the technology itself and ignore its economic and psychological ramifications. There seems to be an assumption, the same assumption the Japanese mistakenly made, that there is a strong pent up demand for sharper, wider TV pictures. Our research at MIT indicates that the nature of demand is conditional and much more complex than originally assumed. Consumer interest in HDTV depends on the nature of the program material, the size of the video screen, the viewing distance from the screen, and the expectations of the viewer. Digital television and integrated broadband systems can be much more than just old TV sets with slightly sharper pictures. Therein lies the opportunity for an American initiative of vision to move out ahead of our competitors in Europe and Japan.

Integrated digital systems, like the exploration of space, and nuclear energy before, have special characteristics of scope and national interest which require the attention and involvement of federal authorities. There is no reason to apologize for such an involvement. I am pleased and encouraged by the growing interest and concern expressed by the leadership of the executive branch and of Congress. But the time is short. Let's get on with it.

The CHAIRMAN. I thank the gentleman very much for his testimony.

Our next witness is Mr. John Eastling, President of Liticom Ltd., San Francisco, California. The Chair recognizes Mr. Eastling.

STATEMENT OF JOHN EASTLING, PRESIDENT, LITICOM LTD., SAN FRANCISCO, CALIFORNIA

Mr. EASTLING. I thank you, Mr. Chairman, for the opportunity to present my views at this hearing. I am encouraged by what I have heard from the comments both from the panels and from Members of the Congress.

My background is 25 years in the computer business. I am currently working in law office automation, and I see the HDTV from a different perspective. From my perspective, I am a user of HDTV today. It is simply a high resolution work station which presents multiple windows to the viewer, and it answers your question of why HDTV is not just a clearer picture. It is not a clearer picture because the work station has a powerful computer in it, it has a lot of memory with 16 million bytes of random access memory in our work stations. We typically have eight or ten different windows that are being viewed at any one time.

You only need to think about it briefly to realize that the human mind is much better served by the tools available, if you have multiple views of the work that you are addressing.

To me, the issue of analog versus digital TV is a nonissue. Of course, this country will want to standardize on a digital TV.

The issue that I would like to address, and it is just one issue today, and that is, what are we going to build HDTVs out of, because the semiconductor industry and particularly Silicon Valley where I make my home is bleeding to death and, specifically, we don't make any DRAMS in this country, and if you don't have any DRAMS, you can't build computers, and if you don't have any DRAMS, you can't build HDTV. That is a device which this country hasn't forgotten. After all, we only invented it within the last 20 years, but we are out of that business. We have gone from a 100 percent share of market to about a 10 percent share of market, and we are on the decline. That is something that this Congress needs to do something about.

So in very simple terms you have been talking today about a use of DRAMS. You have used the words "food chain," and the DRAM sits between the Congressional initiative called SEMATECH, which is semiconductor manufacturing technology, but no manufacturing, and HDTV, which is an end use of large amounts of memory. You heard Mr. Pearlman talk about 25 percent of the cost of the TV being ICs, and the biggest single component will be DRAMS. The Japanese projection is that within ten years, two out of every three memory chips will be in HDTV, whereas today it is about one out three memory chips that are in consumer electronics. So the balance will shift. Again, it doesn't take very much reflection to realize that if you are in the computer business and your primary component, your commodity, the largest single cost element in a computer—I am talking now about the box electronics being the memory chip—if you become a fallout product to a Japanese con-

sumer electronics industry, you also will not be able to compete in the computer business.

What we are seeing in this country is our computer companies becoming shells. They are shells who do systems integration, and they do so around a set of purchased foreign manufactured technology.

So I would urge that this committee look specifically at the area of the commodity component, the essential component. It is something which you can do something about today, because there is in existence the consortium that is producing the manufacturing technology. But last year, the Japanese put four, count them, four billion dollars into DRAM production. The Koreans put two. We are talking here about a couple billion a year of investment in plant, and for U.S. manufacturers having just lost several billion dollars in the DRAM business—AT&T, previously occupying this chair, doesn't make DRAMs. They have an empty plant in Missouri. I drive by empty plants that used to make DRAMs. There are about seven empty plants in this country that don't make DRAMs.

We need to be back in that business, and we have the technologies. No question about that. As I said, it is an invention of this country. The problem is that the dumping that occurred drove out American manufacturers. We have heard a lot of comments today about the antitrust laws. The issue is one of fairness. And were our antitrust laws applied internationally, then we could not have had the dumping which drove out all the American manufacturers of DRAMs. That is not a very difficult concept either. So the idea is fairness. To eliminate fairness inside the United States because there is unfairness outside the United States doesn't make a lot of sense to me, but the level playing field we are talking about demands that Congress somehow now both fund manufacturing of these commodity parts and protect the people that will match the Congressional funds in manufacturing investment.

There is no question that the Semiconductor Industry Association, that set of companies, is perfectly ready, willing and able to go back into the DRAM business. Three or four of them are talking about it but on a scale that is far too small to achieve economies of manufacturing or to supply the American requirements for HDTV or for computers.

I will stop now with that being a summary of a modestly entitled paper called "America's Blueprint for the Twenty- First Century Technological Leadership," but I would like to submit that paper, if I could, into the record.

The CHAIRMAN. If no objection, your statement will appear in full in the record, and I want to thank you very much for your presentation.

[The prepared statement of John Eastling follows.]

**COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING ON HIGH DEFINITION TELEVISION**

March 22, 1989

***Material Submitted by Mr. John Eastling
President, Liticom Ltd.***

IEEE - USA ENTITY: STRUCTURAL CONSIDERATIONS

TECHNOLOGY CORPORATION OF AMERICA - ENTREPRENEURIAL AFFILIATES

I. FEASIBILITY

There is no inherent conflict between government funding of national interest programs and private entrepreneurial execution. The American military-industrial complex, while maligned for self-perpetuation, incest, and cost aberrations, nonetheless has: 1) Achieved consistent competitive superiority (ask any F-14 pilot off Libya); and 2) Manifested vision, risk-taking, and technical leadership. To overcome constructive criticism of this program (TCA), it must be clear that bureaucratic central planning will not replace marketplace tests of performance: cost, function and reliability. Just as the Japanese foster competition within their designated key industries, including TV and DRAM, this American response is based on *market principles*.

II. PRINCIPLES OF OPERATION

The first principle is *competitiveness*, the simplest measure of a technology catch-up plan. Since WWII, our international competitors have largely been able to follow USA products, avoiding the pitfalls that become visible only after the leader experiments, stumbles, and discovers a workable solution. American HDTV and DRAM products will be readily compared to those from Japanese leaders. Ask General Motors about consumer recognition of value from international sources.

The second principle is *economic incentive*. Extraordinary commercial achievement merits extraordinary commercial reward. The USA has a fine tuned mechanism for evaluating economic performance. This program (TCA) need only avoid interference with that capital market mechanism. Entrepreneurial effort is the goal - the program structure must foster such an environment, not strangle it.

The third principle is *sunset withdrawal* of support after successful launch. Permanent crutches engender permanent dependency on non-market conditions.

Finally, *capital cost and availability* is the economic meter. Given adequate capital and open markets, entrepreneurs will aggregate talent and exhort extraordinary effort. Since their career investment parallels capital investment, their instincts reflect market reality: avoid unreasonable risk, leverage economic advantage, eliminate dependency, and most importantly, identify personal success with economic performance.

III. SCOPE OF INTEREST

A structure incorporating the above principles can be quite straightforward - it is in essence a national venture capital entity. Business plans are invited/evaluated/selected; capital is provided; returns are measured. The scope of interest: HDTV and DRAM. Capital requirements are roughly \$8 billion and \$2 billion, respectively. Long-term, low-interest loans = vehicle. Ownership and actual cost of capital are the incentives.

IV. EXAMPLE

DRAM Entrepreneurial Affiliate: Bids for construction, facilitation, and management of a plant with capacity for a minimum of 500 million 16 Mb parts/year are invited from firms with prior DRAM expertise. Successful bidder commits to invest \$200 million, and receives \$2 billion loan guaranty, plus interest subsidy @ 80% x prime rate. Interest is deferred for the first 2 years, principal payments begin after 4 years, interest subsidy expires after five years. Ownership is 80% TCA, 20% bidder at inception. If working parts are shipped in quantity of at least 1 million parts per month (1Mb), with yield @ 50% within 2 years, a second 20% ownership is transferred. If 10 million parts per month, 70% yield (4Mb) is achieved within 3 years, a third 20% ownership is transferred. If marginal product cost of \$5/part (4Mb) is achieved within 4 years, a fourth 20% ownership is transferred. If annual capacity of 500 million 16 Mb parts at 70% yield and marginal cost under \$5/part is demonstrated within 5 years, then all interest and principal is forgiven, and the final 20% of ownership is transferred. A successful outcome would provide the world's largest and lowest-cost DRAM manufacturing facility, and a restoration of technology momentum in semiconductors.

Conversely, if operations are unsuccessful, i.e., none of the milestones set out above are met, then at the end of five years, the equity of bidder is forfeit, and the plant is sold to the high bidder at auction. Middle ground scenarios (e.g. need for additional capital, partial achievement of goals) cause adjustments accomplished through the board of directors: management change, interest subsidy change, etc.

The viability of entrepreneurial subsidiaries with extraordinary performance/incentive goals has been proven repeatedly in the high technology sector. Negotiation of actual parameters requires knowledgeable parties on both sides, those whose prior experience is on point.

MEETING THE CHALLENGE

AMERICA'S BLUEPRINT FOR TWENTY-FIRST CENTURY TECHNOLOGICAL LEADERSHIP

February 1989

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I. Introduction: Blueprint Ingredients & Focus

The purpose of this blueprint is to set forth a practical, concrete program that achieves a breathtaking goal for the United States - *21st century technological leadership*. The scope of discussion begins with "strategic initiative" because a vital national interest is at stake, and must be addressed by a national quorum. Focus is both necessary and possible: the right steps logically follow from today's competitive reality, foundational national policy, and limited alternatives.

The initiative encompasses three ingredients that qualify as both presently endangered and critical to technological leadership: *HDTV, computers and semiconductors*. These ingredients will form the centerpiece of the 21st century home. They will enable delivery of *information, education, and entertainment* into the living unit. Their various utility devices will be as universal then as heat, light, and power are in the home today. All three derive from products were largely invented and commercialized in America during the post-WWII era, yet are symptomatic of this country's slippage in technology.

HDTV (High Definition Television) is the next advance in universal visual services, offering improved video display and incorporation of image processing. Essentially no TV sets are manufactured in the U.S.A. today. Yet, this product group alone accounts for a significant portion of the trade deficit (approaching a negative \$50 billion annually), and will be the single largest use of semiconductors within ten years.

Computers are reaching the pervasive state already occupied by television, as information processing becomes essential to all productivity improvements. At present, the U.S.A. retains its lead in computer technology and manufacturing; however, the industry has been targeted by foreign competitors, and our world market share is declining.

Semiconductors are basic components in all electronic devices, including TV's and computers. As such, they have become analogous to other commodity natural resources - e.g. oil and wheat - that are products of technological process, and become manifested in a multitude of unique end-use products. The U.S.A. semiconductor industry is not yet in as dismal shape as TV manufacturing. Nonetheless, the impact of unfair trade practices, intellectual property theft, and concentrated international competition is more evident in semiconductors than in computers. Moreover, leadership in one is impossible without leadership in the others. No one should underestimate the exposed status of the computer industry.

As the focus of this initiative, the 21st century home will continue to provide primary societal influence on personal attitudes, ambitions, development, and acquisition of knowledge. Children already receive much of their pre-school learning through television and computers. In the future, both classroom and homework will increasingly rely on HDTV/Computer devices to deliver one-on-one personalized instruction. Adult job training and opportunity seeking, shopping, banking, and voting will also benefit from access to vivid, comprehensive, selective information delivery to the home.

An increasing portion of the typical American day is spent watching TV for *entertainment* at home. Inevitably, this efficient, mass medium will become a primary tool for *educational* and *informational* exchange purposes. HDTV is not simply a clearer picture; the concept includes advanced capabilities inherent in the combination of HDTV visual effects with built-in computer management of extensive data and image banks. This data may be stored in the home or accessed from the home. Such advanced capabilities will stimulate creation and delivery of specific, customized, personal development programming. Imagine the educational impact of a history lesson portrayed on a large screen with picture quality equivalent to 35mm slides, presenting multiple simultaneous views for a single student of: 1) actual historical footage; 2) strategy and context analysis by an expert instructor; 3) simulation of alternative tactical decisions; 4) in depth statistical records; 5) question-and-answer stop-action/review/re-try/focus; 6) cross-reference retrieval of related topics (image and/or text). Reversal of today's disturbing trends in the American educational system - class-size, teacher competence, student performance - certainly will be realized in large part through this technology.

II. Approach: Establish Strategic Initiative

A. CRITERIA

Evaluation of alternative choices, for a program worthy of this goal and this effort, requires sweeping criteria with real-world measures. Consider the following attributes of a technology initiative:

1. Minimal impact on the American economic system.

Our system is a 200 year continually evolving success story. No other economic system has matched market-driven capitalism, as the Soviet Block now acknowledges. Only those countries who honor the American market and trade structure have achieved competitive economics. This initiative, or any other viable strategic program, must foster and not disrupt the long-term principles that have worked so well: free trade, competitive markets, entrepreneurial reward, risk of failure, return on investment.

2. Maximal leverage of current American strengths.

Our market size and selectivity exceeds all others -- it tests product viability sooner and more thoroughly. Our capital structure is larger, more responsive and flexible, and more exacting, than any other. Our industrial base reacts to opportunity, and discards lost causes, more quickly than any other. These unique attributes provide first order economic discrimination for every strategic initiative, good or bad.

3. Minimal impact on present competitive structure in the U.S.A.

The virtual absence of any significant American manufacturing presence in either television or semiconductor memory devices illustrate two points: a) the necessity for this strategic initiative, and b) the ability to minimize impact on existing private domestic manufacturers.

4. High payback to all constituencies.

Primary beneficiaries of a *technology* initiative should be:
 a) Education -- qualifying Americans for 21st century opportunity;
 b) Industry -- creating meaningful employment; c) International Stability -- military superiority from domestic weapon sourcing;
 d) Economic -- trade deficit elimination.

Our shared societal objective is to increase quality of life. Economically, that objective is met by creating jobs in technology-based, capital-intensive industries, and creating a work force with superior qualification to fill those jobs.

5. National Interest.

The program must justify Presidential launch, Congressional implementation, and national consensus. Its long term concept, catalytic foundational steps, and concrete strategic goals must be appropriate to guide yet-another crucial transition in the American way of life.

B. AREAS OF OPPORTUNITY

Few programs can meet the criteria set forth above. The Space initiative of the 1960's exemplifies a successful strategic program with immense technology fall-out. It, too, was a response to stiff foreign competition. The Energy initiative of the 1970's exemplifies a failed attempt. Education represents the strategic crisis of this decade, as was Civil Rights in the 1950's. Americans respond to challenge, successfully more often than not.

Soviet Perestroika presents a historic opportunity, just as it confirms the stunning realization that the American system does work better, both economically and militarily. That opportunity is to shift (somewhat) our defense program towards longer term goals -- by strengthening our economic power, which has always been the source of our military superiority.

Japanese challenges to American hegemony -- in technology, quality, labor/management, and trade -- present a second historic opportunity. Collectively, the Japanese challenge usurps the Soviet threat as our number one strategic concern, and merits the same national support, as did the launch of Sputnik in 1957.

As we survey our industrial base and prioritize opportunities for strategic initiatives, the decade of the '80's has seen mixed results: a resurgence in automobiles and steel; stabilization in textiles; continued strength in agriculture, lumber, and aircraft; continued uncertainty in energy; but devastation in banking, consumer electronics, semiconductors, and international trade. Without our express targeting of technology, productivity, and competitiveness, the 21st century may well see declining quality of life. The nation cannot afford to avoid making choices, nor can all praiseworthy goals be simultaneously pursued.

C. RECOMMENDATION

Adopt a strategic initiative to re-establish technology leadership in the U.S.A. Initial concrete tactical steps are to assure domestic manufacturing of HDTV products, and their essential component--dynamic random access memory (DRAM). Expected strategic benefit is reversal of the decline in American's technology base - micro-electronics, physics, instrumentation, process control, data transmission, image processing, electronic packaging.

D. RATIONALE and COMMUNICATION with the CONSTITUENCY

HDTV and DRAMs represent massive scale and critical advanced technology. The \$50 billion annual negative trade deficit in consumer electronics equals more than a third of the nation's entire trade deficit and nearly 100% of the trade deficit with Japan. There is no significant American manufacturing presence in television specifically, or in consumer electronics generally. Two out of every three DRAM devices will be in consumer electronics by the year 2000, double the current proportion. Computers (now the largest DRAM requirement) will be a side-market for DRAM production. DRAM output has been growing at a 40% compound annual rate since its invention in Silicon Valley in the early 1970's. Yet no American company now has a measurable market share in merchant DRAMs, and only one captive plant (IBM) remains as a significant American source of DRAMs for computer manufacture. DRAMs drive mainstream semiconductor manufacturing technology, since they are by far the largest volume of single semiconductor device manufactured. The Japanese control over 80% of all DRAM production, and over 90% of the merchant DRAM market.

Despite the astonishing rapidity of the decline in American manufacturing presence in both consumer electronics and DRAMs, *re-vitalization is achievable*. American firms retain many essential technologies, lead in basic research, hold strong distribution positions, and are prepared to re-enter competitive manufacturing. The disincentive that must be overcome is a history of massive losses. These were in part caused by mistakes of American labor and management, and the well-known short term financial focus in capital markets. Other causes involve closed foreign markets, targeted industries, theft of intellectual property, illegal dumping, foreign acquisition of U.S. firms, and foreign government subsidies for R&D and for long-term low-cost capital. The litany of cause-and-effect is well chronicled elsewhere. A strategic initiative in technology will accomplish, as a side-effect, notification to world markets of our resolve to lead, and of the fair play rules under which we will compete. As the trust-busters of the 1890's provided rules for American competition, so too must the nation-cartels learn rules of fair play in the 1990's.

The implications of not doing a technology initiative also merit consideration. Can we afford to be captives of foreign technology? Dependent on foreign weapons suppliers? Doomed to permanent trade deficits and debtor-nation status? Second-rate educators? Suffer continuous decline in quality of life? Emulate post-war Britain's retreat into a Common Market?

Industry associations and government agencies have already laid the foundation for this initiative. The AEA, SIA, EIA, Round Table, CCIA, and IEEE have all taken positions. Congressional action and Antitrust Department acquiescence has enabled MCC and Sematech. New copyright provisions and semiconductor anti-dumping enforcement have occurred in the 1980's, along with GATT and bilateral negotiations. The dollar has been devalued. Individual firms have vigorously and successfully protected their patents and copyrights.

Similarly, American institutions - unions, educators, corporate restructurers - have recognized that benign neglect of international competitive standards means failure. We have begun to adapt, e.g. Japanese methods have been adopted in American factories. International studies of costs, productivity, and student performance have illustrated our deficiencies. We seek solutions.

These constituencies are ready to respond. They recognize the challenge, and await the national call to attention.

III. Mechanism: Steps to Implement

A. ANALYSIS and DECISION-MAKING

Considerable national interest on this issue already exists. The recent FCC review of HDTV rejects Japanese and European proposed standards and requires compatibility with existing broadcast television. Private and public funding of Sematech provides a model for DRAM production, as well as the source of essential domestic technical prowess. Dr. Robert Noyce, perhaps the only modern equivalent of Thomas Edison, serves as the unpaid chief of Sematech and the unquestioned visionary leader of semiconductor technology.

Industry analysis for each program is well advanced. Good candidates for guiding roles on behalf of industry are identified. Capital sizing and component requirements have been studied. *Yet no American thrust will occur without express government support.* There is simply no present possibility of reasonable return on investment, nor therefore of private funding, for American manufacturing of HDTV or DRAM.

Responsibility for preparation of a sound structural format for selection and funding of actual research, products, and plants lies with industry. Similarly, the strategic communication of facts and options must start from informed industrial groups. Political debate on implementation will follow adoption of a national initiative by the President. No lesser voice can launch this program.

B. AMERICAN CONTENT REQUIREMENT

Our national policy of free trade is sound and has served us well. Exceptions are rare and must be justified by pre-emptive national interest. Examples of existing American content requirements are most DoD and NASA procurements, the Strategic Petroleum Reserve, most Agriculture Department programs, and the Superconductive-Supercollider program. GATT permits national content programs in certain situations.

Other countries make far more use of national content programs, either express or implied, than does the U.S.A. For example, Japan protected and subsidized its industry segments in TV, computers, and semiconductors at a time when its national policy called for strategic initiatives in such segments. Japan will not be heard to complain when identical steps are used for identical reasons with respect to HDTV and DRAM.

The program justification for selecting HDTV and DRAM as American content is straightforward: *they encompass fundamental technology.* The national interest requires that such technology be resident in this country. These programs enable near-term manufacturing of very advanced electronic products, which in turn fosters long-term technology leadership. These two programs have the necessary scope -- in breadth of technical specialties, job creation and training, and trade impact -- to be meaningful.

While the parameters are subject to further analysis, this paper assumes a 30% American content requirement for HDTV (measured against total manufacturing cost, except for DRAMs) plus a 100% American sourced DRAM for HDTV. This assumption would allow substantial foreign content, as is sensible given the present foreign domination of the field. HDTV products would be carefully defined, but would include broadcast equipment, consumer sets, and recorders.

Given 100% of domestic DRAM sourcing for HDTV, a manufacturing facility comprising roughly 30% of world DRAM capacity would suffice. Approximately \$2 billion net new capital investment is required. Some extension of Sematech charter would be appropriate, and a plant operator would be selected from among American semiconductor firms.

The HDTV program would be somewhat more complex to administer, but would be similar to federal requirements for automobile fleet mileage performance placed on each manufacturer, with product mix left to individual firms. Capital requirements would be proportionally larger than for DRAMs, but a higher portion could be expected from private sources.

C. OBJECTIVE: REVITALIZE AMERICAN DRAM/HDTV LEADERSHIP

Given the fundamental technology rationale, will programs in these two areas achieve the desired result of American leadership? An affirmative answer assumes cohesive execution of the entire proposal, as opposed to piecemeal partials. The lessons evident from the semiconductor experience over the last decade teach us that well-executed foreign government targeting of certain critical industries can effectively eliminate American competitors. It is to this nation's credit that foreign adoption of predatory practice has only recently affected our broad national interest. In response, our policy must communicate clearly to both domestic and foreign competitors: 1) America will assert and protect its vital interest in technology; 2) America will not abandon free market principles.

Incentive for re-entry into an abandoned business can best be provided by lowering the cost of capital. For HDTV, public support of R&D and loans for plant investment are means to that end. Sufficient infrastructure remains in the TV set industry such that it can respond to such incentives. For DRAMs, a more commodity approach is required. The infrastructure is also in place, but manufacturing for profit is unlikely over the ten year horizon of 4MB/16MB devices. Competitive marginal costs can likely be achieved, once the initial plant is facilitated. A government-furnished-equipment approach (widely used in DoD procurement) may be necessary.

The fall-out of technology to civilian and military developments should occur as it has in the past. No structural adjustment is necessary. DRAM manufacturing will foster domestic equipment and process improvements in those semiconductor products where the U.S.A. remains strong. HDTV manufacturing will reduce the need for American entrepreneurs to license foreign manufacturers in order to see their ideas commercialized.

D. FUNDING, SCOPE, SUNSET

The mechanism for administering government funding is assumed to be a new Technology Corporation of America, with \$10 billion in initial loan authority. Its governmental parentage would likely be Dod, as with Sematech. Nominally, the breakdown would be HDTV = \$8 billion, DRAM = \$2 billion. Loan forgiveness (or transfer of GFE) would be based on performance by the private entities that obtained TCA funds. Specific performance parameters for product, cost, quality, and schedule would be negotiated and monitored. Failure would be tolerated (as in bankruptcy), not rewarded. Success would be measured in terms of entity self-sufficiency.

The scope of product interest is HDTV and DRAM. For these two areas, world-class manufacturing is the goal. Therefore, plant investment must be scaled to compete with the largest foreign competitors. Similarly research objectives must seek leadership, not pursuit. Development of certain applications, such as in educational use of HDTV, will be included, but most such derived technology will be beyond this initiative.

Finally, the term of TCA will be limited to the ten year period 1990-99. Start up funding of the DRAM facility may, of necessity, occur in the next few months. If this initiative is to be successful, then its progeny will be successfully launched in the next decade. Moreover, an international accord, which strengthens prohibitions against predatory practice, may replace the need for such stark retaliation in areas of fundamental interest.

IV. Reference Material and Invitation for Support

You, the reader, are in a select group. You already are aware of the problem, and you may be working on some part of the solution. Our most pressing need is strategic communication: placing the facts in the hands of those who can move this initiative forward. Please contact the Blueprint Task Force.

The Chairman. Our next witness would be Dr. Alan McAdams, Ithaca, New York.

**STATEMENT OF DR. ALAN MCADAMS, SCHOOL OF MANAGEMENT,
CORNELL UNIVERSITY, ITHACA, NEW YORK**

Dr. McAdams. Thank you, Mr. Chairman. It is a pleasure to be here today representing the Technological Activities Council, the principal technology council of the IEEE USA. I am an economist, but I am a member of the IEEE as well. The IEEE, as you know, is the world's largest engineering society, with over 300,000 members worldwide. 240,000 of them live and work in the United States. And it is a pleasure to be here, especially in this distinguished company.

I have heard from the discussion thus far that my prepared testimony essentially preaches to the choir. I would like permission to extend my remarks later with another written statement.

The CHAIRMAN. With no objection, so ordered.

Dr. McAdams. Although we are preaching to the choir, I think it is important for people to realize that a professional community such as the IEEE is at least up to speed with this committee here. In a number of ways, we may be a little bit ahead. We hope so.

One of the things we would like to focus on is the need for a systems approach to what we are dealing with. I think Mr. Eastling's comments are very important. It does not do us much good to have high definition television, if all it does is to assemble products made by other countries into our boxes.

In my prepared remarks on the next-to-last page, there is a diagram which suggests the outcome of a recent workshop at which some 60 people fully cognizant about the important issues in the electronics industry participated, including both gentlemen on my left. The outcome of that essentially was that we proposed three consortia be established.

Now I don't want to have it said that I am in disagreement with Dr. Neuman. The language that came out of our workshop was that we wanted industry-led consortia to revitalize the U.S. electronics industries. I accept his characterization of the problem with that terminology. Nonetheless, that was the terminology which we used in our discussions, and I don't care what the terminology is, as long as we get the job done.

What this diagram shows is an interrelationship among the entities with industry, the Congress and the administration. What is suggested is that there is a need for not just the military supporting HDTV and the other consortia activities, but that we must have a civilian component. It was suggested at our workshop that this could be centered in NIST, but whatever the Department of Commerce decides is the most appropriate mechanism for them would be fine, as long as we get the consortia moving.

The three consortia we identified were the HDTV itself, and the AEA, as you know, is working on a business plan for that, and they are listed then as the industry leader for that.

Now the second consortium and the third represent two elements that would make it possible for this country to have the components to put into an HDTV, and we believe that there are suffi-

cient spillover benefits from these two consortia, independent of HDTV, such that they should go forward, even if the HDTV itself was not moving; however, together, they perform a number of the important elements of a market. You need not just producers but also consumers of product, and the HDTV then would be a consumer of the output of the consortium for DRAMs, the dynamic random access memories, and the high resolution system, about which we have heard so much. But we feel that all three of these consortia should move forward.

Back to Dr. Neuman's comment, we list that one these consortia does not have an industry leader, and that is the one for high resolution systems; however, it may well be that that is the one that is moving most rapidly, because that is the one that Craig Fields and people from the Department of Commerce are working on most heavily now.

I would like to echo a few comments made by others. These deal with the fact that when we do start in any of these areas, essentially, we are establishing infant industries, and it is an infant industry that is moving into what was described at our workshop as "a lousy business." And that lousy business is the current television business in this country, and I think that Mr. Pearlman made very clear why that business is lousy today. What we have is American firms, essentially, without access to foreign markets and foreign competitors with access to our market, and they are able to earn their keep in their home markets with large profits and they are able to sell in our markets, and I liked his words. He pointed out that they achieved scale economies and learning by doing by having large-scale operations that go to a market such as the U.S. with 240 million consumers.

The market in Korea, for example, is for 9 million households with 40 million people, and the American market is a little bit more attractive to them than that. I think it is important to recognize that if we are going to be in HDTV, that you can't beat something with nothing, and that is another reason for having these two supporting consortia identified.

I would like to echo another comment, and that is that as we look at the electronics food chain, it is extremely important to recognize that we can no longer afford to respond to what John Eastling has just suggested would not be acceptable activity under the U.S. antitrust laws, if those were applicable worldwide, and that we need to compete at the commodity level in order to protect higher margin businesses. We need to have commodity level mass production activity in this country or we will lose it all. And I think that we may be closer to that point than many people currently are willing to admit.

On the question of what would happen if we did not have these initiatives going forward, I can speak from personal experience and from a number of phone calls that are coming into my office from around the country, that many small firms would be out of business, including a number that are involved in the highest technology activities that we are able to identify.

This country has the problem that without the customers there are no scale up opportunities for the small companies that operate here. The place where they get their customers now is in Japan.

Many of them are turning their technologies over to the Japanese, because there is no U.S. alternative, and I think it is also fair to say that Mr. Pearlman might not have been appearing here today representing Zenith in the television business, if it had not been for the DARPA initiative. There are a number of well-documented things in the news media suggesting that the shareholders of his company were urging them to sell or close down their business.

The time is short, and I will leave my comments at that.

[The prepared statement of Dr. McAdams follows.]



UNITED STATES ACTIVITIES

Promoting Career and Technology Policy Interests of Electrical, Electronics & Computer Engineers

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EXTENSION OF REMARKS OF ALAN K. McADAMS ON BEHALF OF THE TECHNOLOGY ACTIVITIES COUNCIL OF THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/ UNITED STATES ACTIVITIES

ON
ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE
BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

MARCH 22, 1989

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The Institute of Electrical and Electronics Engineers, Inc.

EXTENSION OF REMARKS
of
ALAN K. McADAMS
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ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE
before the
Committee on Science, Space, and Technology
United States House of Representatives
March 22, 1989

The following remarks serve as an extension of the testimony presented by Alan K. McAdams on March 22, 1989, before the House Committee on Science, Space, and Technology, at their hearing on "Advanced Television Systems--Regaining The Competitive Edge."

The extended statement makes the following points:

- The United States' electronics technology base is in a situation of crisis. To meet the crisis, the IEEE-USA proposes a national initiative and the creation of three consortia to begin to revitalize the U.S. electronics industries.
- The causes of the problems faced by the U.S. electronics industries and the interrelationships among these problems are complex and multifaceted. Solutions must meet the complexities of the real problems.
- The advent of High Definition Television (HDTV) provides an opportunity and a challenge for U.S. owned firms to reestablish leadership in the consumer electronics market in the U.S. with technologies that are crucial for both military and civilian use. The IEEE-USA recommends the creation of three industry-led consortia in such dual-use technologies as next steps toward this goal. These consortia are:

<u>Consortium</u>	<u>Industry Leader</u>
1) HDTV (High Definition Television)	AEA (American Electronics Association)
2) DRAMs (Dynamic Random Access Memories)	SIA (Semiconductor Industry Association)
3) HRS (High Resolution Systems)	(Not yet Identified)

By implementing these consortia, the U.S. can begin to reverse the current downward spiral and begin to revitalize the U.S. electronics industrial base.

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- U.S. government policies in support of these consortia are absolutely critical to assure that U.S.-owned firms can become reestablished in vital dual-use sectors of the electronics industry. IEEE-USA has identified and endorsed the first steps; these steps must be taken NOW!
- Such consortia do not represent a panacea. However, their creation would represent a profound change in U.S. policy toward its industrial base and that would provide an important signal to U.S. trading partners.

The rationale presented in support of these conclusions is:

- Currently conditions in the U.S. domestic markets are not hospitable to American-owned firms that produce television and related dual-use technologies. Even when an American-owned firm can be a low-cost producer of products of high quality, it cannot stay in business because of strategies that are rational for its foreign competitors, but destructive for U.S. firms.
- The U.S. is vulnerable when American-owned firms lack capacity to produce critical dual-use components. This has been the case with dynamic random access memories (DRAMs)--currently in short supply--which are an essential component of computer systems, military systems and many consumer electronics products, including advanced televisions.
- The U.S. computer industry faces a serious challenge from the Japanese. Because the Japanese control close to 90% of the world's production of DRAMs for the merchant market, they have the ability to price their computers and other products far below current levels. Should the Japanese choose to do this, many U.S. computer and other high-technology manufacturers would be at a severe competitive disadvantage.
- U.S. supercomputer firms are especially vulnerable to Japanese competition because they are essentially stand-alone, non-vertically integrated companies that must rely on other entrepreneurial firms or on their Japanese competitors for semiconductors and other critical components.
- The Japanese economy is structurally different from the U.S. economy and from the economies of all other industrialized nations. This difference has meant that U.S. electronics firms--especially those that produce dual-use technologies--are at a substantial disadvantage when they are in competition with firms from Japan even in the U.S. market. The U.S. cannot expect the Japanese to change an approach to their economy which is rational for them and has proven to be so successful for them. Therefore, the U.S. must deal domestically with factors that it can control if U.S. firms are to survive in domestic and world competition with the Japanese.

The U.S. must take action now to create these consortia and must provide support sufficient to assure their success.

Introduction

The analysis below presents some important facts about two market places in the United States with implications for military and civilian needs: that for consumer televisions and related products, and that for dynamic random access memories (DRAMs). The important conclusions from the analysis of these market-places is that under current conditions of world trade, these U.S. markets are not hospitable to U.S.-owned firms even when those firms achieve low costs and world-class quality.

There are structural reasons which help to explain why the U.S. market is relatively unattractive to U.S. producers. A main reason is that many foreign producers that compete in the U.S., operate from relatively secure home markets in which they earn the bulk of their profits. (That is, they use their home markets as the source of the bulk of their profits and the U.S. markets to gain overall scale economies). It is economically efficient from their viewpoint to operate in this fashion. A specific example in relation to Korean manufacturers of color television sets is used to illustrate the different incentive structure which these foreign firms face, and the implications of that incentive structure for U.S.-owned manufacturers in the U.S. market.

Next, evidence is presented that shows that the Japanese economic system is truly different from the economic systems of other industrialized economies. This evidence is of two kinds: first, a series of recent economic studies establishes some key differences in the ways in which the Japanese economy performs as compared to the economies in other countries; and, second, anecdotal material which for years has been consistent with the hypothesis that Japan's economic structure is "different." The recent studies thoroughly document and reinforce these anecdotal examples.

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- Because the Japanese approach is so successful for the Japanese, and because it is so different from our own, we must come to grips with the following imperatives:

- First, we cannot expect the Japanese to function the way we would in their position.

- Second, we must recognize that there are few incentives for the Japanese to change.

- Third, we therefore have little alternative but to deal domestically (with those factors which currently are under our control) to redress the imbalances which result from the interactions of our two very different economic systems.

The three consortia recommended by the IEEE-USA workshop and currently in the process of being established, represent early steps in this redress. If we are successful in creating such consortia, which will permit U.S.-owned manufacturers to perform profitably in global markets under current conditions of competition, then we will have achieved the first steps toward the goal of reestablishing U.S. industrial presence in dual-use electronics technology areas.

The Significance of HDTV

The advent of high definition television presents both an opportunity and a challenge to this country. We have the opportunity to reestablish the U.S. position in consumer electronics. From experience we have learned that the absence of a U.S.-owned base in consumer electronics has resulted in compounding problems. For example, recent innovations in consumer electronics such as VCRs are almost all imported from abroad. The fact that the products of these industries must be imported adds to our trade imbalance. Further, the absence of the U.S. design and manufacturing capability in these areas has deprived the U.S. of spill-over benefits into other industries that have both military and civilian implications. Under today's conditions, approximately one third of all the DRAMs produced in the world are used in consumer electronics products.

Japanese forecasts suggest that by the turn of the century, two thirds of the DRAMs produced in the world will be used in consumer electronics products. The remaining third will be used in products including computer systems of all types. Under such conditions, the revenues from consumer electronics could well defray the cost of R&D for future generations of products as well as for the production facilities of all the DRAMs that are produced. In the higher technology areas, this could then imply that DRAMs would be essentially a "free good." The implications of such power in the hands of others for U.S.-based computer manufacturers are rather dismal to contemplate. More is said about this problem below.

Facts About the Market for Color Television in the U.S.

In the mid 1980's a study done for General Electric showed that GE's costs were substantially above those for a number of others in the industry and that therefore it would be desirable for GE to purchase its color TV sets from someone else for distribution by GE. General Electric chose to subcontract to Matsushita for the manufacture of television sets for sale under GE's label. Shortly thereafter, General Electric acquired RCA in one of the largest corporate mergers in history. General Electric then commissioned the same consultants to study the total manufacturing facilities of the combined organization. In mid 1986, the consultants reported back with a strategy to make RCA a low-cost producer of color television sets and with majority domestic U.S. content in its sets.

Based on this information, General Electric shifted the production of its television sets from Matsushita to RCA and began to implement the strategy, achieving considerable success. The consultants concluded that the devaluation of the U.S. dollar contributed little to the net gain that was achieved. Nonetheless, despite these gains, the fact that the quality of its

RCA-brand TV's were favorably rated in relation to those of Sony, especially for picture quality, the prices of RCA sets were substantially less than those of Sony. (See table below.) GE found that the color television business in the United States was not sufficiently attractive for GE to remain in the business.

Comparison of Quality Ratings
and Prices
RCA vs SONY Color TV Sets
Screen Sizes 13-27, From 1-84 to 6-88

Date of Rating	Screen Size	# of Sets Rated	RCA Rating	SONY Rating	RCA Price	SONY Price	SONY Price As % RCA
1-84	19"	18	7	8	\$730	\$730	100%
1-86	25"-27"	18	4	5	\$800	\$1250	156%
3-87	20" Stereo	20	15	1	\$499	\$700	140%
3-87	19" Mono	19	11	13	\$299	\$412	138%
6-88	13"	18	10	6	\$250	\$350	140%

Note: The box indicates the higher rating of the two.
Source: Consumer Reports - For dates indicated.

The new strategic approach was shared with Thomson, the French company that purchased GE's TV business. The new strategy significantly enhanced the price that GE received from the sale. Despite the success of the new strategic approach (scheduled for completion this year), Thomson Consumer Electronics has yet to claim in its reports to the U.S. Trade Commission that its U.S. operations are profitable. That this is the case in the market for color televisions in the United States, is indeed disturbing.

Why then, you might ask, would anyone wish to sell color televisions in the United States? If low-cost producers are unable to be profitable operating in this market, why would anyone stay? Yet the market is served with color television. What explains this?

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While preparing this testimony, an interesting coincidence occurred. A case being analyzed in one of the author's classes happened to involve a Korean manufacturer of color television sets. The analysis of that case provides a partial answer to the above rhetorical question. The incentives to the Korean manufacturer were different from those of American manufacturers.

As is true in a number of oriental societies, there is a favorable public reaction to the largest domestic producer of a given product. The largest domestic producer is viewed by the domestic population as being "the best." This was true of the Korean firm in question. Some 80% of Korean consumers surveyed, rated firm one's color TV's as the best Korean sets. (The fact is that as of the time of the case, the firm's product was rated 18 of 18 listed; and, "significantly lower in quality," than the first 15 sets in the above-referenced ratings--see the table on page 6 for source.)

Firm one was the largest Korean producer of color television sets. As such, its television sets were able to command a significant premium in the home market--largely in response to this cultural assumption relating market penetration and quality of product. In any case, as of 1984, the date of the case in question, this firm (and a number of Taiwanese firms) had just been adjudicated by the U.S.'s International Trade Commission, to be "dumping" its products in the United States. That is, essentially identical products were being sold in the United States at a price substantially lower than the price at which those products were sold in the Korean market.

The problem faced by the managers of Korean firm number one related to the fact that a competitor Korean firm had approximately matched their sales volume in the United States. If the competitor were to exceed the first company's total sales volume, then that would taint its image as "market leader." This would likely have had substantial negative effects in the domestic market.

The only channel through which one could respond to the challenge of its competitor quickly was to sell additional output to U.S. discount firms. Company two also was distributing in the U.S. through discount houses. Because of the imperatives of the Korean home market, firm one felt that it had to continue to offer concession-priced T.V. sets in the United States. It was imperative for them to remain the market leader. Their position in the United States had substantial payoffs in higher prices in their home market.

These firms are engaged in a global game with the U.S. marketplace as the one through which they gain reputation, economies of scale and low costs for their total production, and perhaps eventually, quality improvements through competition with others in the United States.

A key fact in this analysis is that these firms make very substantial profits in their home markets. This is irrespective of the level of profitability in the U.S. market. U.S. firms that are unable to participate in the Korean home market (or in the Japanese home market) for TV sets, do find themselves at a disadvantage. They lack an alternative through which to achieve profitability.

The television market has been one in which dumping has been consistently proven in accord with U.S. trade legislation. In the 1970s the main problems related to dumping by Japanese companies. We have just seen that in the 1980s Korean (and Taiwanese) companies were following a similar pattern with similar result.

Japanese firms such as Hitachi are vertically integrated firms. They participate not just in the consumer electronics market, but also in the market for semiconductors, including DRAMs, as both captive and merchant producers; their product lines extend to computer systems, from micro, to mini, to mainframes, to supercomputers. The table on the next page, taken from the IEEE-USA report entitled "U.S. Supercomputer Vulnerability," dated August 8, 1988, shows three integrated Japanese firms plus various U.S. firms. The Japanese firms thus have

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the ability to withstand pressures in one segment of their multi-centered activities through profits they achieve in others. For them, profits from consumer electronics, whether from the home market or from the U.S. market, can be used to help them penetrate markets for higher technology products. The situation faced by U.S. manufacturers of dynamic random access memories for the merchant market (circled item on the table below) over the past several years is quite different.

Market Segments Participated in by Selected U.S. and Japanese Manufacturers of Supercomputers and/or Semiconductors

	CRAY	CDC/ETA	TI INTEL Motorola AMD ETC.	AT&T	IBM	NEC	FUJITSU	HITACHI
Super-computers	x	x			RE*	x	x	x
Main Frame Computers		x			x	x	x	x
Intermediate Computers					x	x	x	x
Mini Computers		x		x	x	x	x	x
Micro Computers					x	x	x	
Consumer Electronics						x	x	x
Semiconductors								
- Merchant			(x)			x	x	x
- Captive				x	x	x	x	x

* Re-entering.

The DRAM Semiconductor Problem

For a two-year period in the mid-to-late 1980s there was a huge over-supply of DRAMs. This over-supply resulted from heavy investment by the Japanese, well in excess of their domestic needs, combined with output by the Japanese factories at their planned capacity.

In the Japanese system the production manager is evaluated on his ability to produce high-quality products at low costs. This is generally best achieved by producing at the full capacity of operation of a given plant. This is what Japanese production managers do. The question of what happens to the output once it has been produced, is a "marketing problem."

The U.S. market has been the market of last resort for Japanese as for other firms. That is, excess output has generally been shipped to the United States. In this case the result was the extended period of chaotic pricing in DRAMs, with prices falling well below the cost of manufacturing.

U.S. merchant semiconductor firms are not vertically integrated. When the prices of their largest volume product, DRAMs, became depressed substantially below cost, these U.S. firms had no source of revenues other than semiconductors. They were forced to retreat from the market. They experienced the frequently-cited figure of 2 billion dollars in losses. The Japanese firms experienced the also frequently-cited figure of 4 billion dollars in losses. Nonetheless, the Japanese firms remained in the market for DRAMs. The 4 billion dollars of losses can be looked upon by the Japanese as an "investment" that has established their dominance over another market area. For the U.S. firms, 2 billion dollars in losses have remained losses.

The U.S. government exerted its efforts to convince the Japanese to cease "dumping" DRAMs into the U.S. market (and into third-nation markets). These efforts achieved success approximately at the point that U.S. firms exited from the market--and by chance, the point when worldwide demand for DRAMs began to pick up. The result was a sudden worldwide shortage of DRAMs. In response to the shortage, prices skyrocketed.

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There has been some controversy over the "real" cause of the shortage of DRAMs in 1967-68 and even up to the present. Some people point to naturally-occurring problems of change-over from one generation of DRAMs to the next--that from the 256K-generation to the 1-megabit-generation--as the explanation for the shortage that followed so closely on the heels of the exit of so many U.S. firms. However, students of the subject, including Dr. Kenneth Flamm of the Brookings Institution, who have compared the actual output of Japanese firms with the "forecast" made by MITI (The Ministry of International Trade and Industry in Japan) several months prior to that actual output, say (and MITI denies) that MITI ordained its level. In any case, there is an uncanny congruence between the MITI forecasts and the level of actual output. (Though in more recent periods, there has been some deviation from the forecast in a positive direction.)

After the U.S. firms had left the business, the net effect of the shortage was substantial windfall profits to the Japanese firms that continue to offer DRAMs. Two U.S. firms do continue to manufacture DRAMs, Texas Instruments and Micron Systems of Idaho. Nonetheless, Japanese output approximates 90% of world output of merchant-market semiconductors at this time.

What can we learn from this series of events? The most significant factor to note is that when the U.S. does not have domestic capacity in the hands of U.S.-owned firms, the U.S. is vulnerable to market swings such as those just discussed--irrespective of the cause of those market swings. This history suggests that the U.S. must have its own capacity in the hands of U.S.-owned firms.

This brief history also suggests the answer to the question, what difference does it make if the U.S. manufactures its own products or buys them from abroad? When you are dependent on others for products that are vital to your industry, you have lost control of your industry.

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The recent very high price of DRAMs to U.S. firms manufacturing computer systems has had a substantially negative effect on the competitiveness of the computer systems of those firms. Note that as integrated firms, the Japanese manufacturers that sell DRAMs at high prices in the U.S., due to the current shortage, are also producing those products for internal use in their computer systems. Thus they have the ability to price their computer systems at a significantly lower price, should they choose to do so.

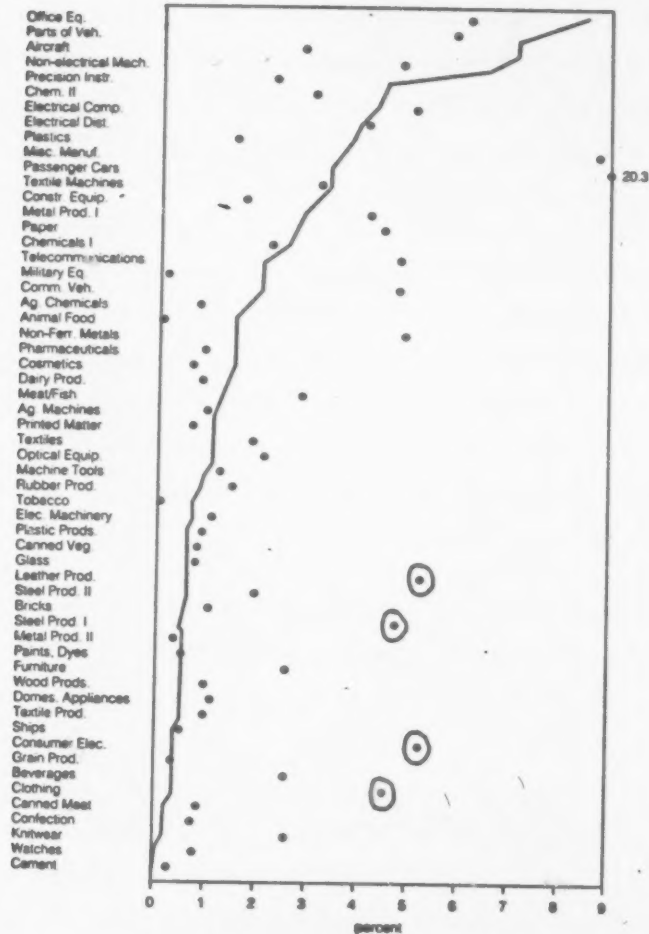
The Japanese Economy is Really "Different"

There has been much anecdotal evidence suggesting that doing business in Japan is quite different from doing business anywhere else in the world. These anecdotes apply to industry after industry, time period after time period, with conditions that are substantially different from one time period to the next, and from one industry to the next. The recent book by Clyde Prestowitz titled, Trading Places, compiles example after example.

Many economists have tended to dismiss this evidence as unconvincing, self-serving or worse. More recently, however, increasingly rigorous economic studies have been made of the phenomenon of interrelations between the Japanese economy and the economies of other industrialized nations. Evidence of both kinds was recently pulled together in the document, "Analysis of the U.S. Japan Problem: the Report of the Advisory Committee for Trade Policy and Negotiation," presented to the U.S. trade representative, Carla Hills, in February of 1989. Three graphs from this document, especially in the context of the vast anecdotal evidence that is presented in the document and elsewhere, make the point.

There is a pattern of trade for most industrialized societies. This pattern is evidenced by that of the United States shown in that document (Figure 5.2 from page 60), which is reproduced on the next page.

MANUFACTURED EXPORTS AND IMPORTS AS A PERCENTAGE OF TOTAL EXPORTS, 1985:
UNITED STATES



Source: "U.S. Competitiveness in the World Economy: An Update" by Bruce Scott, a paper presented at the Workshop on Competitiveness, Harvard Business School, July 12-18, 1987. Copyright © 1987 by the President and Fellows of Harvard College. Reprinted by permission of the Harvard Business School: JAPAN IN THE WORLD ECONOMY, Balassa and Noland, Institute For International Economics, Figure 3.3. Note: imports = •; exports = ____.

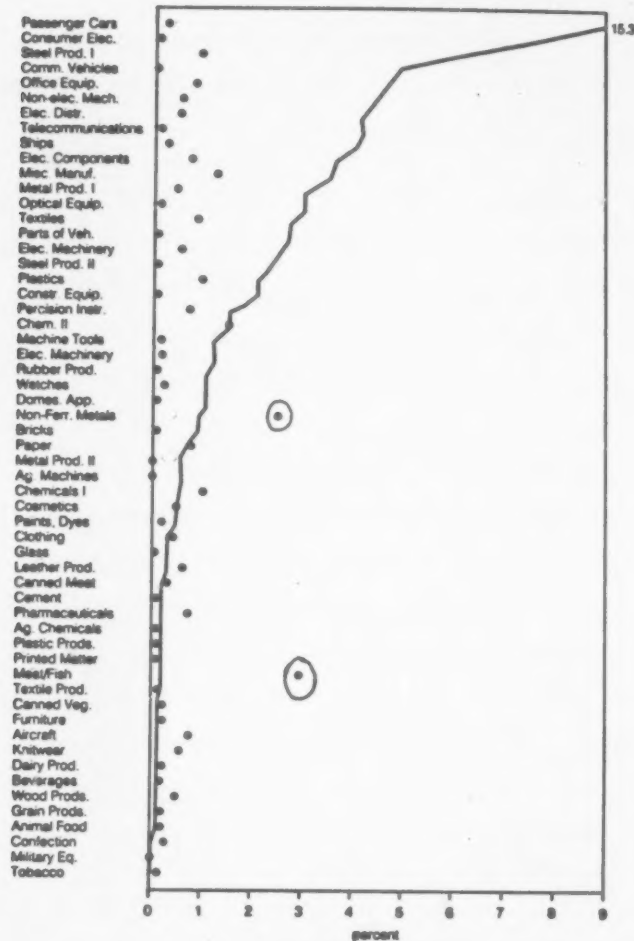
-14-

It is the pattern, not the details, that is important about this document. This diagram shows exports (as a solid line), in various industry manufacturing segments as a percentage of total exports for the United States in 1985, a typical year. It also shows imports in those same sectors (as a series of dots), as a percentage of the same base; that is, also as a percentage of total U.S. exports.

One can see that the pattern of dots tends to follow the pattern of the solid line. The solid line connects the export level of each of the successive industry segments from low-export to high-export segments. The highest export segment for the U.S. is "office equipment." The four circled items represent unusual import levels. These are "clothing," "consumer electronics," "steel products 1," and "leather products." These are obviously product areas where the U.S. must import since it has very little domestic capacity remaining in these items. In any case, the pattern is one which shows that with increasing levels of export in manufactured goods, a typical country will have increasing levels of imports in those same manufactured goods. This is because the domestic economy begins to specialize in particular elements of the high-export sector, while importing other elements from abroad. In the study which underlines the document, its authors prepared similar figures for Germany and several other highly industrialized countries. Their patterns even more closely approximated the stated relationship than does that of the United States.

Now let us look at Figure 5.1, reproduced from page 59 of that report and included as the next page. This shows the same relationships for manufactured exports and imports for Japan in 1985. With the exception of the two circled dots, (the first being for imports of "meat and fish" and the second "non-ferrous metals" i.e., aluminum--essentially congealed electricity) the Japanese pattern is strikingly different. Irrespective of the level of export, Japan's manufacturing industries import very little. This pattern applies to no industrial country other than Japan.

MANUFACTURED EXPORTS AND IMPORTS AS A PERCENTAGE OF TOTAL EXPORTS, 1985: JAPAN



Source: "U.S. Competitiveness in the World Economy: An Update" by Bruce Scott, a paper presented at the Workshop on Competitiveness, Harvard Business School, July 12-18, 1987. Copyright © 1987 by the President and Fellows of Harvard College. Reprinted by permission of the Harvard Business School: JAPAN IN THE WORLD ECONOMY, Balassa and Noland, Institute For International Economics, Figure 3.4. Note: imports = *; exports = ____.

The Japanese pattern is especially important for the electronics industry of the United States. The Japanese market is now the largest market for semiconductors in the world. It is a market in which the Japanese produce huge quantities for export, as we have just seen.

Now let us turn to the third diagram, Figure 6. 1, reproduced from page 100 of that report, and included here as the next page. This diagram shows U.S. semiconductor producers' market share in Japan. At the bottom of the diagram, is listed a whole series of liberalizations, market openings and so fourth, trumpeted by Japanese governmental agencies as demonstrations that the Japanese market is "open."

Again it is the pattern that is important. The graph shows a constant pattern, a pattern that does not change over time. The U.S. share remains virtually constant at approximately 10% of the Japanese market. This pattern is consistent with that in the earlier figure, Figure 5.1. Irrespective of their levels of exports in the manufacturing sectors, Japan, unlike other countries, does not import.

Despite all the negotiations which have taken place in the semiconductor industry, the Japanese market has remained essentially closed to American semiconductor firms. The opposite is obviously the case for the U.S. market. The U.S. market is open to semiconductor (and other electronics) manufacturers anywhere in the world.

With the Japanese market essentially closed and the U.S. market essentially open, U.S. firms are at a substantial disadvantage. Japanese firms are able to make profits in their domestic markets, and to price at marginal cost--or above as the situation permits--in the U.S. market. U.S. firms being essentially

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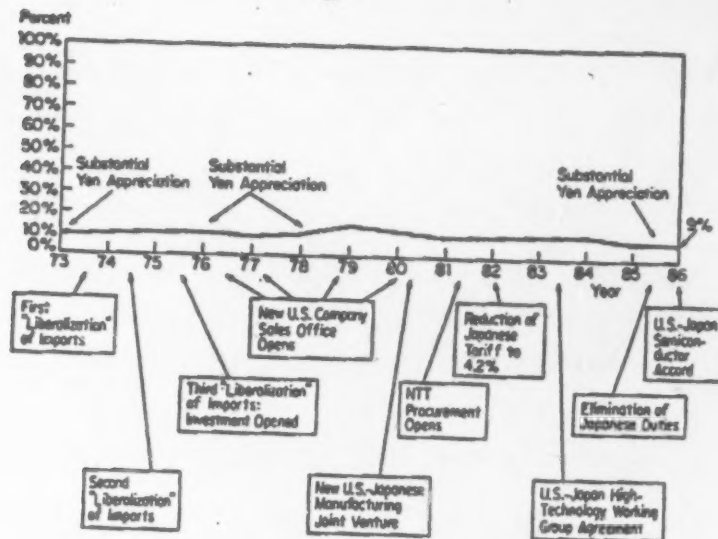


FIGURE 2.8
U.S. Share of Japanese Semiconductor Market

Source: Semiconductor Industry Association as reproduced in *Trading Places: How We Allowed Japan to Take the Lead*, by Clyde Prestowitz.

limited to these domestic markets, are dependent on these markets for their total performance. When the U.S. domestic market price is depressed--as was the case with the heavy over-supply of DRAMs in the 1985-86 time frame--U.S. firms, especially those that are "stand-alone" companies, can be quickly driven from the fields.

The U.S. semiconductor industry is populated with companies that have grown up from entrepreneurial start-ups. Most of the firms that serve the merchant semiconductor market are stand-alone companies. The table repeated on the next page, reproduced from the IEEE-USA report entitled "U.S. Supercomputer Vulnerability," shows the pattern of U.S. as compared to Japanese electronics firms. As noted earlier, the Japanese firms on the far right of the table are vertically integrated firms participating in multiple market segments. Most importantly for this discussion, they participate in consumer electronics, in the production of semiconductors for the merchant market, in the production of

semiconductors for their own internal use both in consumer products and in the more advanced products, in the computer industry, and in supercomputers.

Market Segments Participated in by Selected U.S. and Japanese Manufacturers of Supercomputers and/or Semiconductors

	<u>CRAY</u>	<u>CDC/ETA</u>	<u>TI INTEL Motorola AND ETC.</u>	<u>AT&T</u>	<u>IBM</u>	<u>NEC</u>	<u>FUJITSU</u>	<u>HITACHI</u>
Super-computers	(X)	(X)			RE*	X	X	X
Main Frame Computers		(X)			X	X	X	X
Intermediate Computers					X	X	X	X
Mini Computers		(X)		X	X	X	X	X
Micro Computers					X	X	X	
Consumer Electronics						X	X	X
Semiconductors								
- Merchant			X			X	X	X
- Captive				X	X	X	X	X

* Re-entering.

The objective of the table in the IEEE report was to demonstrate the vulnerability of the U.S. supercomputer firms. They are much less integrated than are their Japanese competitors. (Note new items circled on the table.) Cray, the largest supercomputer manufacturer in the world, is effectively a stand-alone company.

Nations such as Japan can and do follow a pattern of using success in dominating a given area of electronics technology to provide leverage for extending the position into related areas. This is a pattern which we have seen over and over

in the U.S. economy. A protected home base for Japanese firms makes it extremely difficult for U.S. firms to compete against strategies of this kind.

Conclusions

Consumer electronics has proven to be a stepping stone into higher technology markets for those foreign firms that have chosen to focus on these businesses. The U.S. market is the main market outside of their home market upon which foreign electronics companies can focus. With their protected home markets, they are not dependent for their ultimate success on the cash flow from the consumer electronics or other businesses in the United States.

The experience of GE and RCA is of extreme importance in interpreting the real significance of the pattern of competition in electronics in the U.S. marketplace. U.S. firms have made their share of mistakes over the history of these markets. However, the RCA situation suggests that even when it can be the low cost producer, the U.S. firm may not be economically successful in the U.S. home market.

The situation in DRAMs fits the classic textbook pattern of anti-competitive behavior: actions that result in driving the competitor from the market place, followed by increased prices to recoup whatever losses were incurred in driving the competitor from the market place. Whether this pattern was conscious, inadvertent, or influenced by less-than-optimal U.S. policies, is beside the point. The pattern has taken place. U.S. computer manufacturers have discovered to their dismay the degree of their vulnerability to shortages of supplies from overseas suppliers, whatever the cause of those shortages.

It is in the interest of producers and consumers of U.S. electronics products alike to have the power to respond to such emergencies through U.S.-owned and controlled firms. It is in the national interest that this be brought about.

Perhaps the best way to complete this testimony is to restate the substance of the conclusions of the workshop referred to earlier:

- The survival of the U.S. industrial base in vital electronics sectors is at stake.
- To address the problem, we endorse industry-led consortia with government cooperation and support
- As a vehicle for addressing the crisis, dual-use technologies that meet both civilian and military needs should be developed in participation with both the Department of Defense (through the Defense Advanced Research Projects Agency [DARPA]) and the Department of Commerce (through the National Institute of Standards and Technology [NIST]). We applaud DARPA for supplying seed money for high resolution systems. Their initiative is of historic significance in recognizing that future low-cost military technology is intimately related to the health of U.S. design and full-scale manufacturing capability in consumer electronics, and that the initiative must be a market-driven, not a technology-driven enterprise.
- We recommend high-resolution systems (HRS) technology and world-class manufacturing as key areas for action. Displays and DRAMs are the most critical elements of this process.
- Industry-led consortia in threatened market segments must operate in an environment which is economically attractive. The government should facilitate this objective through the following actions:
 - a. Adopting measures for the provision of government financial support for U.S. industry-led consortia;
 - b. Recognizing the importance of an hospitable antitrust environment to the attraction of private U.S. capital;
 - c. Equalizing capital costs for U.S. participants in these global markets.
- These consortia must be dedicated to improving the competitiveness of U.S. firms and must contribute to the revitalization of the U.S. electronics industries. Consistent with these objectives, the consortia should be open to participants on a reciprocal basis.
- The IEEE-USA proposes to amplify and refine these concepts through a continuation of these workshops and debates. The objective is to help build the will, consensus, and resources necessary to meet the crisis.

Mr. BROWN. (presiding) Thank you very much, Dr. McAdams. We will recognize Mr. Krall next, and Mr. Walker will say a few good words about Pennsylvania.

Mr. WALKER. Well, thank you, Mr. Chairman. I do want to welcome Harold Krall here, who is President of Cardinal Technologies of Lancaster, Pennsylvania, which is in my district. He is proof-positive that we have high tech other than new grease for wagon wheels in my district. And I do welcome him here. We are very lucky and appreciative to have him as a member of this panel. Cardinal is a leader in electronics product development, having been independently established as a spin-off of the RCA and GE merger. Harold is a widely recognized expert in this area, and I warmly welcome him as a part of the panel this afternoon. Thank you, Mr. Chairman.

Mr. BROWN. We look forward to hearing from you, Mr. Krall.

STATEMENT OF HAROLD KRALL, PRESIDENT, CARDINAL TECHNOLOGIES, INC., LANCASTER, PENNSYLVANIA

Mr. KRALL. Thank you, Mr. Chairman. Congressman Walker and members of the committee.

I would like to make a few summary remarks, since the hour is late and I would like to ask that my written testimony be entered into the record.

Mr. BROWN. Without objection, so ordered.

Mr. KRALL. Thank you. I think that so many witnesses here have said so much, again, preaching to the choir, I think it would probably be inappropriate for me to again say that, but I want to take us to a higher altitude view for a moment of this thing, because I think so much of the discussion is treating the symptoms rather than the cause, and I would talk to what I think about is the cause of the dilemma we find ourselves in here.

Certainly, there is a view that would say the private sector in our system has the motivation and the tools to do anything that it wants to do and over many years it certainly has accomplished great things. Witness the personal computer industry which has grown up overnight in less than ten years, and companies like Apple and Sun and Microsoft and hundreds of other fine companies have come into being, largely funded with private capital, and created this personal computer business which none of us even really thought existed ten years ago or a few more than ten years ago.

So that is a prime example of how the private sector in the United States can be preeminent and is admired by the rest of the world, and yet we have had other examples in the past. In the company that I grew up with, I spent 27 years working for RCA, which was a company founded by the U.S. Government in 1919. It has been described earlier by a number of the witnesses. It was founded ostensibly for the creation of ship-to-shore communications for the Navy and for commercial shipping, and a young entrepreneur guided the company and developed what we later called broadcasting and radio and then television, and certainly, RCA on a very limited investment by the people of the United States was able to make an enormous return.

There are many other examples. One could go back earlier in time when the United States granted the land to the railroads, and we crisscrossed the Nation with the railroads which created a tremendous transportation network, and then many years later, we kind of were shocked that we would give private enterprise such a tremendous largesse as a ten-mile wide swath entirely across the Nation several times over.

So I think our country's history has had many examples where the government and the private sector have worked independently and they have worked together, and the results have been quite spectacular. I think the interesting thing about what we are talking about here today is, whether we call it HDTV or ATV or whatever we call it, it seems like the topic which is certainly one that the people of the United States can grasp and feel and touch and understand the benefits and the risks to failure is really, in a sense, a microscopic issue on a much larger scale, which is, are we going to become a post-industrial society? Much has been written about this. A popular view held by many of our citizens is, the United States has moved out of manufacturing and into services and that is the future, and we will let the manufacturing to the newly industrialized countries, Japan, at first, and now Korea, Taiwan and Mainland China soon, and so forth.

I think much also has been written that that is probably not a viable concept, that that will not permit the United States to remain a world leading economy, and, in fact, not a post-agricultural society. For those of us that in the Lancaster area, agriculture is alive and well there, and today the Nation grows its own food with less than 2 percent of its population as compared to perhaps 100 years ago, 60 or 70 percent of our population performed the same task. But we don't consider ourselves in this country, I believe, a post-agricultural society. We have made it a very efficient industry and many, many people support agriculture in the form of services. Around Lancaster, we have laboratories, and we have support services that support our farmers, even though not a very large percentage of the people in our region do farming any longer.

I think the same thing has happened in manufacturing. What should have happened here in the United States is, instead of exporting manufacturing, we should have automated, mechanized it, and we have certainly the technology to do that. Computer-integrated manufacturing is something that we are very good at, but which we have not widely adopted.

So what we really come to grips with here is, are we going to be a post-industrial society, and I think what a lot of the witnesses and the panel are really saying is that if we are going to be in HDTV, we are going to have to—there are so many linkages in and out of HDTV to other parts of the economy, that we can't just do HDTV alone. If we are not going to manufacture the basic components—the picture tube, the DRAMs, the liquid crystal panels or the fiber panels or whatever the technology, wherever that takes us.

If we aren't going to put the policies in place to move the capital which we have in such abundance, but which is being so heavily wasted today in essentially redistribution as opposed to the creation of new wealth. It is just mind-boggling to me, having now

started a small company and gone through the maze of raising capital, how difficult it is to raise a few million dollars at a time when one can within months raise \$25 billion to take over a large conglomerate company and essentially cut its R&D, streamline its operations and essentially reduce its competitiveness on a world scale.

I think what really needs to be addressed here are the issues of policy as it relates to coupling capital and our very good productive labor resources here in the U.S. and technology. Much has been said about inadequate technology. I believe we have all the technology we need. We hire a lot of young engineers out of school today. They seem as smart as they ever did, probably smarter. They are eager to go to work. We would have more of them. When we say, why don't we have more—why are half of our graduate students foreign students? Well, it is because our students, our technical students can't find good jobs today. I believe if we created more jobs, if we build our manufacturing economy back to the level that it used to be, we would find that lots of people would say in engineering, and we wouldn't be talking about having half of our technical students be foreigners.

So again, I think it is an issue of symptoms and causes. Obviously, there are things that I think the government should do. Being from Lancaster, most of us in that part of the country lean a little bit further to the right than perhaps some other parts of the country, and we like to see the private sector do its own thing and the government leave it alone as much as possible, but I have to say in this case, I think this is an opportunity, in the world we now live in, which is a global economy, where we have the Europeans with highly nationalized industries, RCA, as I used to know it, is now a property of the people of France. And it is almost a shock to me when I see, you know, the changes that that has caused. Likewise, having spent many years in the Pac Rim countries, I have had a chance to see what a consortium of government and large banks and syndicated companies, small, large and extraordinarily large, can do.

So we really have to find an American solution, which I believe requires a different approach, a new partnership with government and industry and academia to achieve the results that we want to achieve, and what better place to do it than HDTV or advanced television. I think it is a containable, cost effective experiment to see what it is we could on a much broader scale in so many other industries that have already been left behind.

Since the hour is late, I would like to close my remarks and thank you.

[The prepared statement of Harold Krall follows.]

ADVANCED TELEVISION SYSTEMS *REGAINING THE COMPETITIVE EDGE*

Cardinal Technologies, Inc.

March 22, 1989

Summary

Advanced Television Systems (ATV's) are vitally important to the future wealth and power of the United States. Television and related information display technologies are the primary media for our communications, leisure, learning, and defense. These media enable us to be aware of critical events in the world around us. Our eyes are our most important sense, the broadest information pathway into the brain. Nearly all citizens are aware that visual information is more powerful than information brought to us through other sensory experiences. We've adopted phrases like "seeing is believing" and "a picture is worth a thousand words" to express the undeniable clarity and power of visual information.

The problems represented by ATV and HDTV provide a manageable opportunity to deal with a more serious problem, i.e., the loss of U.S. competitiveness in product manufacturing. The U.S. has successfully dealt with similar problems in the past. Such was the case following the close of World War I when the nation was faced with the near certain inability to develop the burgeoning new field of radio and wireless communications. The government was instrumental in the formation of the Radio Corporation of America in 1919—a move to protect the U.S. from the European domination of what was thought to be a tech-

nology for ship-to-shore communications for the Navy and commercial shipping. As it turned out, radio developed into a major industry, broadcasting, which in turn spawned the electronics industry as we know it today. The return on investment to the people of the U.S. from radio technology far exceeded the modest funding by the government.

More recently, the post-Sputnik era generated government support for the electronics industry in the form of assistance to semiconductor manufacturers. This largely government-sponsored support has provided much of the basis for integrated circuits which have so richly improved the lives of nearly all of our citizens.

Much has been said about the inability of the U.S. to compete in consumer, commercial, and industrial electronics. The U.S. *has* sufficient technical expertise, productive labor, and capital resources to compete on a worldwide scale, except for policies which do not adequately take into consideration foreign electronics industry and government competitiveness strategies. Many European electronics manufacturers are nationalized or operate with substantial assistance from government. Electronics manufacturers in the PACRIM syndicate with one another and with large banks, and in some cases, with government. The competitiveness of the U.S. electronics industry can be dramatically improved by modifications to current policies, i.e., coordination, limited R&D funding, tax, antitrust, and temporary import tariff policies.

Government Role in HDTV

The government can and should play a role in the following areas:

- Coordinate an assessment of ATV and computer systems utilizing the combined talents of government, university, and industry resources.
- Coordinate an ATV technical standards effort to minimize unnecessary development of inferior products.
- Through DARPA and Commerce, fund ATV R&D programs with emphasis on smaller businesses and universities. Require early demonstration of results.
- Grant R&D tax credits to all businesses engaging in ATV and computer systems R&D.
- Grant long-term capital gains tax reduction for small and medium size businesses engaging in the development and manufacture of ATV and computer systems.
- Impose temporary import duties for ATV and select computer products, e.g., a 5% additional duty for five years.
- Enlist Commerce to more effectively assist small and medium size businesses in exporting electronic products. The problems facing small U.S. businesses in exporting electronic products far exceed U.S. small and medium business resources.

Industry Role in HDTV

The most serious industry problem for ATV systems is caused by the negative opinions that the capital markets currently hold about consumer electronics and

technology. This could be rectified quickly with capital gains tax reductions, R&D credits, and direct funding of high-risk projects.

Unavailability of basic ATV system components such as high density memory chips, high resolution cathode ray tubes, deflection yokes, liquid crystal panels, etc. is another serious impediment to the growth of U.S.-based ATV systems producers.

The risk-to-return ratio must be improved to attract new capital to the consumer electronics industry. Foreign businesses, and in some cases their governments, have taken a dominant market share, long-term approach that has driven U.S. capital from this segment. Current government policies in the U.S. make it far more attractive to redistribute rather than to create new wealth. Policies must be created to correct this.

Technology and Market Research

The U.S. should keep its effort broadly based due to the uncertain outcome of technical solutions for ATV systems. This uncertainty is a problem for ATV components and systems manufacturers and will require many years, possibly even a decade, for resolution. It is likely that a leap-frog approach, rather than adoption of current HDTV technology, will give the U.S. the greatest benefits for ATV systems.

Market research needs to be performed *after* basic ATV product technology can be adequately demonstrated. Market research in advance of product viability has been largely unsuccessful in the past. This research can be adequately funded by the private sector.

Background

Cardinal Technologies, Inc.

Cardinal Technologies, Inc. was founded in February, 1987 by Harold R. Krall and six other RCA managers after the merger of RCA and General Electric in 1986. Cardinal's physical and intellectual assets comprised a significant part of what RCA and GE had available for the product development and manufacture of advanced television and personal computer systems.

Cardinal was organized to develop and manufacture consumer, commercial, and industrial information display and computer systems products. Located in Lancaster, Pennsylvania, Cardinal's newly constructed 60,000 square foot building houses a highly automated electronics assembly facility and one of the largest installed IBM mainframe CAD/CAM product engineering systems in the U.S.

Through advanced computer design and manufacturing technology, Cardinal has been able to successfully compete with foreign producers of information display and personal computer systems products.

Harold R. Krall, President and CEO, Cardinal Technologies, Inc.

Harold R. Krall is President and CEO of Cardinal Technologies, Inc. Previously Mr. Krall had a career of 27 years with the RCA corporation. He held executive positions with responsibility for product development, manufacturing, and marketing of television and computer products. Mr. Krall has had substantial experience with European and PACRIM electronics product manufacturers.

Demonstration

Cardinal will be prepared on 3/22/89 after the hearings to demonstrate a prototype ATV system which utilizes an IBM® PC/AT®, NTSC signal source, and VGA color monitor. This advanced development system demonstrates a few of the potential features of ATV utilizing the open-architecture of a personal computer.

Mr. BROWN. Thank you very much, Mr. Krall.

Now we recognize the witness we have been waiting for all day: the last one.

[Laughter.]

Mr. Sie, we welcome you here, and I understand you may have something you would like to display as a part of your testimony, and we certainly welcome that also.

**STATEMENT OF JOHN SIE, SENIOR VICE PRESIDENT, TCI,
DENVER, COLORADO**

Mr. SIE. Okay. The time is late, and it is a long morning stretching to afternoon.

Good afternoon. I appreciate the invitation to address this committee. My name is John Sie. I am Senior Vice President of Telecommunications, Inc., or TCI. TCI is a cable television operator, and our company and our affiliated companies operate in 46 States, and we have approximately 11 million subscribers. We are part of a cable industry. As you may or may not know, cable now passes 55 percent of the American households or about 50 million American households watch their television through cable. Also, a significant portion of our cable subscribers watch over-the-air broadcast stations through the cable media.

So it is very important to the cable industry and TCI, vitally, on our consumer's behalf, to know that any introduction of HDTV will provide no disruption, be cost effective, as well as offering the best quality television possible.

As a member of Corporate America, we are also very much interested in the national policy of competitiveness, trade deficits and so on. We do feel that there has been a news overload. You can't go a week without seeing something about HDTV is coming. HDTV is coming. Certainly, this morning you have heard that perhaps we are too late, why the government hasn't been doing enough. The Japanese and the Europeans are putting so much money into it.

I believe that how to spend money and what to spend it on is more important than just having money. We have put together a comprehensive plan on what to do from a national policy perspective and how the government can help in making that come about.

Number one, we believe that—and recommend that the government should set a national policy by the year 2000 that we would develop in America a processed digital HDTV system which operates with less than 6 MHz bandwidth, so that the broadcasters, cable and all other television distribution media, can compete vigorously within that system.

The processed digital system is a leapfrog strategy. It basically uses the American strength in computer microprocessors and software, where we have a strength, and where, as Russ Neuman mentioned, that both the Japanese NHK system and the European Community's Eureka systems are analog-based.

What is the difference between digital communications and processed digital? Well, quite simply, if you look at digital HDTV, they are talking about using 145 MHz of spectrum. Right now we are transmitting each television signal using about 6 MHz. So that would take about 24 channels of capacity. So in Washington, the

broadcaster, if you want to adapt that system, you can broadcast one channel. And I think that is going backwards.

A processed digital is a digitally based HDTV system that could operate within the 6 MHz boundary.

So what is the difference between processed and regular digital?

Well, in the regular digital communications where the computer industry has been familiar with, up to now, every bit of the information is important. It has your address, my address, what's our credit check, and so on; however, when we are talking about HDTV, the television image is unique and different. As you look at me, if you dissect me, if you could, on 1/30 of a second, much of the information within a centimeter does not change. So there is a lot of redundant information in the television picture.

Also, on the receiver side, there is only a certain amount of neural response of the human eye. We can't respond to microseconds. We have a certain time response. Again, there are redundancies. So if we can know how to process the television picture to match with the optical system, we can have tremendous compression, so that we are able to put it into the 6 MHz spectrum.

Many companies in this country are working in that area. Bell Telephone Laboratories, MIT's Media Labs, and recently Intel purchased the DVC technology from Sarnoff Labs. That means the computer people are starting to get to understand the video which is our business. Now with Intel's DVI, they have been able to compress by a factor of 120 to 1, which will show the possibility with the improvement of large-scale memory chips, processing chips, as well as more R&D to integrate those various diverse disciplines—we believe a ten-year time frame is very realistic.

Now many of the people doubt the fact that we can do that in ten years. I would like to remind people, for instance, the Intel's 80386 microprocessor chip, which is sort of the workhorse of PC today, has the equivalent computer capacity of the IBM large frame, mainframe, 360/50 of 20 years ago.

So you can see the rapid cost reduction available in digital technology.

What do we do in the meantime? Well, we recommend and support that the FCC ensure that any analog-based HDTV system must use the current NTSC standard within the current 6 MHz, with no disruption of the spectrum allocations. The worst thing we can do is to use some analog base HDTV system that eats up additional scarce spectrum so that when processed digital finally arrives, the broadcasters are dealt out of the picture, because there is no more spectrum left.

It is interesting and ironic that if we are discussing an HDTV system which uses 6 MHz following the NTSC standards, that the United States is ahead in the world. I would like to disagree with Congressman Ritter that we do have such a system. It is a system developed in Sunnyvale, California, by Faroudja Laboratories. It is interesting to note that in Japan, Japan, Inc., is not as monolithic as you think. The MUSE system that we all talk about is proposed and pushed by NHK, which is the government broadcaster, and it will be delivered primarily through DBS, but there are five private commercial broadcasters who do not want to be dealt out of the picture, who are owned by powerful newspapers. And there they

are doing an NTSC-compatible system called EDTV, and they have set up an organization called BTA, Broadcast Technology Association, and last month they invited Dr. Faroudja to demonstrate his SuperNTSC system, and really was exceedingly well-received.

So what I am trying to say is that we have some short-term solutions, so that we can preserve our strategic objective to develop a 6 MHz processed digital HDTV.

Because we tend to get involved and wrapped up in technology and the medium of television, let's not forget about programming, because it is just as important to know what goes down to those TV sets in our homes as well as how it gets there. I can assure you that if I have an NFL Superbowl on a EDTV system, the consumer will watch that versus, say, Chinese classic literature on HDTV.

So programming is very important. I think we have the wherewithal to follow those two-step approaches which should follow, let's not panic. We have the wherewithal. If the government can point the way for a national focus, I think the private sector has the will, the capability and the opportunity to meet that challenge, so that we can regain a technological edge for the 21st century home electronics.

Thank you.

[The prepared statement of John J. Sie follows.]

TESTIMONY OF

JOHN J. SIE
SENIOR VICE PRESIDENT
TELE-COMMUNICATIONS, INC.

ON

HIGH DEFINITION TELEVISION
AND THE
FEDERAL GOVERNMENT'S ROLE
IN DEVELOPING A COMPETITIVE U.S. INDUSTRY

BEFORE THE

COMMITTEE ON SCIENCE, SPACE AND INDUSTRY
U.S. HOUSE OF REPRESENTATIVES

MARCH 22, 1989

Introduction

My name is John J. Sie and since 1984 I have been Senior Vice President of Tele-Communications, Inc. (TCI), a cable company headquartered in Denver, Colorado, which operates cable systems throughout the country.¹ TCI also has invested in cable programmers in furtherance of its commitment to provide American cable viewers with a wide range of quality entertainment and information programs in addition to retransmitted over-the-air programming. At TCI, I am responsible for strategic planning, public policy and program investment.

Approximately 55% of American television households (49.5 million) receive their television signals through a cable system. Accordingly, the cable industry is vitally interested in proposals regarding HDTV and we appreciate the opportunity to testify this morning.

¹Frankly, I have been a "closet technocrat" for the last 15 years. My education and early career development were technical. I received my Bachelors degree in Electronics in 1957 from Manhattan College and my Masters degree in electrophysics from the Polytechnic Institute of Brooklyn in 1958. My technical career started in 1958 at RCA's Defense Electronics Division as a senior member of Technical Staff, working on microwave solid state devices for troposcatter and satellite communications. In 1960, I co-founded and was later President of MicroState Electronics Corporation, a subsidiary of Raytheon Company. Microstate did R&D and manufacturing work for the space and defense industries in areas of advance solid state devices for missiles, radars, and telecommunications. In 1972, I joined the Jerrold Subsidiary of General Instrument Corporation where I developed two-way interactive cable TV, multi-channel and addressable pay-per-show TV scrambling systems. In 1977, I joined Showtime Entertainment, a subsidiary of Viacom International, Inc., as Senior Vice President of Marketing and Affiliates. Showtime is in the business of providing movie based pay-TV services primarily to the cable industry.

The Importance Of HDTV

As you Chairman Roe, Subcommittee Chairman Walgren, and others on this Committee have recognized, HDTV means more to America than television pictures with video quality comparable to 35 mm film and with compact disc quality sound. Over the longer term, there also are expected to be many non-entertainment uses for the high resolution video technology, including: interactive education; computer work stations; satellite photography; defense command and control displays; advanced weapons targeting; and medical diagnostics. Most importantly, if the U.S. Government takes the right actions, then American HDTV in the 21st century will use the most advanced integrated circuits and computer processes in a home environment. Whoever takes the lead in HDTV technology will have the advantage with respect to key components (semiconductors, etc.) and in related areas of computers, software and test equipment.

In short, we applaud the Committee for its recognition that the HDTV competition represents a bigger challenge to our technological leadership in the world than did the color television or the VCR. Decisions made now will affect our place in the world well into the next century.

What The U.S. Government Should Do

The noted management consultant, Peter Drucker, has been quoted as saying that a competitor should never try to catchup -- instead he should "leap frog" the current leader. We could not agree more.

Specifically, we call upon the U.S. Government to:

(1) set a national goal of introducing by the year 2000, an American "processed digital" HDTV system which permits the transmission of a digital-HDTV signal within 6 MHz;

(2) support efforts already underway in the private sector to develop and implement a processed digital transmission system;

(3) promote the introduction within two years of an interim analog-based HDTV system which uses the current 6 MHz NTSC standard, so that the more than \$100 billion invested in broadcast and cable transmission equipment, television sets and VCRs will not be rendered obsolete²;

(4) reserve frequencies allocated for television broadcasting, but not currently utilized, for processed digital HDTV during the transition period when broadcasters will simulcast compatible analog HDTV and non-compatible digital HDTV signals.

²Japan's MITI and its National Broadcasting Company (NHK) have been trying hard to persuade U.S. policymakers that they are the only ones with a HDTV system and are ready and able to make it available to U.S. consumers. What they downplay is that their system is incompatible with existing U.S. television transmission equipment (broadcasting and cable) and television receivers, all of which work with the current NTSC standard of 525 lines, 59.94 Hz frame rate, 4:3 aspect ratio, and 6 MHz transmission standard. Thus, it is not hard to see the Japanese's true objective: the sales of new Japanese HDTV sets full of Japanese components. Yet, there is no need to suffer such problems. An American HDTV system exists now (Super NTSC) which is fully NTSC compatible and provides as sharp a picture as the MUSE system for the largest of American television screens (six-foot diagonal).

These combined actions will:

- thwart attempts by foreign countries to introduce non-compatible HDTV systems in the U.S.;
- ensure that American viewers have access to improved television pictures quickly;
- minimize the cost and disruption associated with introducing HDTV;
- maintain the ability of American broadcasters and cable operators to provide local and national news, information and entertainment programming while permitting other current and potential distribution technologies (e.g. DBS; VCR) to compete in a vigorous fashion.

As you know, the Energy and Commerce Committee and its Telecommunications Subcommittee, with jurisdiction over the FCC, NTIA, production and transmission standards and spectrum allocation, have been examining this issue as well and we hope to testify before them later this year in detail on such issues.

Today, however, we want to keep the focus on our real objective of developing an American processed digital HDTV system. That is where this Committee and the Congress can definitely help.

Why The U.S. Should Focus On Digital-Based HDTV

Analog-based HDTV systems will not be competitive in quality or cost with the next generation of digital-based HDTV systems.

(For the purposes of television signal transmission, "digital" simply means converting an analog HDTV waveform to a series of binary bits of 1's and 0's.) Digital-based HDTV will offer the same revolutionary advancement we have achieved, by way of analogy, with compact discs and digital audio tapes versus standard LP's.

A digital signal:

- suffers from no transmission degradation;
- enables true studio quality image and sound in American homes;
- permits direct integration and signal manipulation between the home television and home computer; and
- promises volume-efficient cost reductions in manufacturing digital HDTV sets.

Furthermore, developing an American digital-based HDTV system lets us "leap-frog" the Japanese MUSE and European EUREKA HDTV systems which are analog-based. U.S. entities have the lead in developing digital-based technology. This work both relies on and contributes to the U.S. leadership position in VLSI circuits, micro processors, software systems and adaptive compression techniques.

What is "Processed Digital"?

A "processed digital" HDTV transmission system can be defined as any digital-based HDTV television transmission system which reduces the frequency spectrum required to transmit a signal by taking into account three major factors:

- a) standard digital compression transmission techniques; and
- b) the specific nature of the video waveform; and
- c) the neural responsiveness of the human eye.

A "Brute Force" Digital Approach Employs Only Standard Digital Compression Transmission

Before discussing the design of process digital, let's first look at transmission systems which only use standard digital compression techniques.

Digital telecommunication systems today routinely exhibit bandwidth compression efficiencies of 4.5 Bps/Hz (i.e. for every 4.5 bits of data, we need only one cycle of RF spectrum to transmit them). For example, a 4.5 Mbps data stream can be transmitted using only one MHz of RF bandwidth. Most digital long-haul microwave transmission systems achieve their compression using a 64-level quadrature amplitude modulator (QAM). As higher levels (256 x 1024) become available on the market, further bandwidth compression of up to 7.5 Bps/Hz is possible.

Now let's design an HDTV system with the following characteristics: (1) a resolution of 1050 x 1050, i.e., the whole screen is capable of resolving into small cells called "pixels," 1050 vertical by 1050 horizontal so that the total number of pixels per screen is 1,102,500; (2) the screen is scanned at a rate of 30 times per second (in order to show continuous motion) with a 2:1 interlace scan; and (3) there are 5 binary bits of information each required to define the intensity (luminance) and color (chrominance) content for each pixel. The total amount of digital information needed to be transmitted every second in this system is 1,653,750,000 bits! Even using a transmission compression of 7.5 Bps/Hz, the required RF spectrum is 220.5 MHz for just one channel of HDTV programming!

Such a "brute force" approach using so much spectrum for digital HDTV is not suitable for over-the-air transmission: there simply is not enough spectrum available without creating new demands on other spectrum users (e.g., land mobile radio, public safety radio, etc.)

This is a serious drawback: it effectively would mean the end of the local broadcastings in the HDTV arena. Local broadcasting has been a hallmark of American television policy since its inception.

The only way to transmit such signals would be through fiber-optic cables. But it would be extremely expensive to install such cables throughout the country and telephone companies would not be able to lay fiber universally to every American home until well into the 21st century. In addition, there are serious technical questions about even the feasibility of transmitting more than a few HDTV channels requiring such great bandwidth even with fiber-optic cable: within the foreseeable future, the state of the art in video switching using sub-micron integrated circuit technology is below 1 Gbps, or at best each video switch at the remote terminal can only handle 4 HDTV channels. Moreover, at a 1 Gbps switching rate, the cost of such switches are not going to be competitive at all.

A "Processed Digital" Approach Greatly Reduces The Necessary Bandwidth

The brute force digital approach described above, utilizing 220 MHz bandwidth, is capable of faithfully reconstituting all ranges of intensity and color for every pixel for every frame. But

it is not necessary to do so given the nature of video images and the limitations on the ability of the human eye to perceive such information.

Even with the most detailed scene and fastest motion, much of the content information from pixel to pixel and from frame to frame does not change. Therefore, instead of sending each pixel of each frame new information every time, the processed digital system only sends information when there is a change.

Think about it: as I testify before you, the only part of the image moving is my face, hands and perhaps my upper body. The table and most of the background remain fairly constant. And remember, for television we are talking about a change only every 1/30th of a second.

The processed digital approach simply sends new information when there has been a change in information. By doing so, much less transmission spectrum is needed.

Furthermore, the pixels can be grouped into cells of several pixels each, further reducing the necessary bandwidth. A receiver can have the adaptive capability of interpolating the proper information for each of the pixels in each group from the coded "change" information being received and processed. The reconstituted image will be perceived by the viewers as having the full resolution.

Because of these factors, it is possible to drastically reduce further the spectrum needed -- that's the "Processed Digital" approach. Many scientists in research labs and industrial enterprises are hard at work developing different variation of the processed digital approach. Of note are Professors William

Schreiber and Andy Lippman of MIT's Media Lab, Arun Netravali and Barry Haskell of AT&T Bell Laboratories, and Intel's DVI Program in Princeton, New Jersey.

Of particular interest is the work being done at DVI. It is an advanced technology which combines the interactive graphics capabilities in personal computers with high-quality television and multitrack audio in an all-digital integrated system. At the heart of the system is a proprietary chip set with a unique video compression algorithm. A technical breakthrough in compression efficiency was announced by DVI in 1988 -- they can microcode one hour of full NTSC television programming on one CD-ROM disk, heretofore thought to be impossible. The chip set and the associated operated software can be in three plug-in boards to PC/AT computers. The DVI system is used for interactive video program designs. It has a real time video compression capability of 30:1 by removing redundant pixel to pixel information within each video frame. This is called intraframe coding. Once the interactive video/date/audio application program is completed, the program can be further compressed by removing interframe redundant information. This would require much more computing and storage capacity and is done off line. Interframe coding of DVI technology can offer another 4:1 compression yielding a final CD-ROM disk containing 1 hour or NTSC video with 120:1 compression.

Although the DVI's current application is institutional for education, training, and the cost of the prototype system is about \$25,000, it's not hard to project what we can do as we continue to improve processed digital, transmission compression, and cost reduction of large capacity memory storage devices in the next 10

years. (Consider: Intel's workhorse microprocessor 80386 has computing capacity similar to the IBM large mainframe computer 360/50 of twenty years ago! Intel is already developing the next generation microprocessor with at least 10 times more capacity than the 80386.)

Quantitatively, a 1.65 Giga bits per second of digitized HDTV signal with a video compression of 120:1, a transmission modulation compression of 5:1 and a 33% capacity for forward error correction would need only 3.65 MHz!

Summarizing, instead of putting a TV set inside a PC, if we reverse the emphasis and put a PC inside a TV, we will do very well for the development of the home terminal of the 21st century, HDTV, and PC all rolled into one.

TCI has engaged Hatfield Associates, Inc. (HAI) under the direction of Mr. Dale Hatfield, to assess the likelihood that, over the next ten years or so, a processed digital HDTV signal could be transmitted via terrestrial broadcasting and cable systems within a 6 MHz RF bandwidth. Their conclusion is that even using today's available technology, such a goal can be achieved. (For the Committee's reference, the Hatfield Assessment is attached to my testimony.)

Conclusion

We at TCI believe that a very intense, well coordinated and well financed effort, bringing together the best minds in video processing, film technology, VLSI, solid state memory technology, microprocessor software, bio-engineering, visual psychophysics, and visually creative programming expertise would rapidly

accelerate the state of the art to bring the most advanced, competitive, and cost effective processed digital HDTV system for the 21st century.

There have been many suggestions as to how the Government can help: direct funding; antitrust relief for joint efforts; matching grants; tax credits; etc. We think this Committee and the Congress should continue to examine these alternatives. But we can and should agree as soon as possible on what we should do: introduce by the year 2000 an American processed digital HDTV system which permits the transmission within a 6 MHz bandwidth.

END

REPORT
ON
THE POTENTIAL FOR EXTREME
BANDWIDTH COMPRESSION
OF DIGITALIZED HDTV SIGNALS

PREPARED BY
DALE N. HATFIELD
OF
HATFIELD ASSOCIATES, INC.

March 20, 1989

DALE W. HATFIELD/HATFIELD ASSOCIATES, INC.

I, Dale W. Hatfield, President of Hatfield Associates, Inc., located at 4840 Riverbend Road, Boulder, Colorado, 80301, declare that:

I received a Bachelor of Science degree in Electrical Engineering from Case Institute of Technology in 1960, and a Master of Science degree in Industrial Management from Purdue University in 1961. I have completed additional graduate work in engineering, mathematics, operations research, and business administration at Illinois Institute of Technology, Case-Western Reserve University, and the University of Chicago.

After graduation from Purdue, I joined Stewart-Warner Electronics as a production engineer. From 1963 until 1971 I was employed as a communications engineer with the Institute for Telecommunication Sciences of the U.S. Department of Commerce. Between 1971 and 1974, I held various communications policy analyst positions with the Office of Telecommunications in the Department of Commerce. In 1974, I was appointed Deputy Chief of the Office of Studies and Analysis, Office of Telecommunications Policy, Executive Office of the President. In 1975, I moved to the Federal Communications Commission where I became Chief of the Office of Plans and Policy. In 1977, I returned to the Department of Commerce where I became Associate Administrator for Policy Analysis and Development, National Telecommunications and Information Administration. In 1981, I was appointed Deputy Assistant Secretary of Commerce for Communications and Information.

In 1982, I left government and established my own consulting organization. Our firm specializes in engineering, economic, market, and policy studies in the telecommunications field. Our clients include firms in the terrestrial and satellite long-haul communications, cable television, local exchange, cellular mobile, broadcasting, specialized mobile radio, and international communications fields. I am also the Director of the Telecommunications Division of University College at the University of Denver where I teach courses in telecommunications policy and regulation and in telecommunications management. I am also an Adjunct Professor in the Graduate Program in Telecommunications at the University of Colorado at Boulder. In addition, I was recently appointed a Fellow of Northwestern University's Annenberg Washington Program on Communications Policy Studies.

I declare that the foregoing is true and correct, that the attached document entitled "The Potential for Extreme Bandwidth Compression of Digitized HDTV Signals," dated March 20, 1989, was prepared under my direction and supervision, and that I agree with the results and conclusions.

Executed on March 20, 1989

by

Dale N. Hatfield

Dale N. Hatfield

The Potential for Extreme Bandwidth Compression
of Digitized HDTV Signals

1.0 Introduction

Hatfield Associates, Inc. (HAI) has been retained by Telecommunications, Inc. (TCI) to assess the likelihood that, over the next ten years or so, a digitally-encoded HDTV signal could be transmitted via terrestrial broadcasting and cable systems within the 6 MHz bandwidth occupied today by NTSC signals. This report reviews current progress and trends in the bandwidth compression of broadcast-quality television signals and in digital transmission technology in order to estimate whether the existing states of the various arts could, with suitable further development, lead to such a goal. The report does not address the transition to fully digital transmission or the different enhancements that might be applied to NTSC technology during the interim.

Video compression and transmission techniques are assumed to be independent in this analysis. The fundamental approach to the problem included estimating the maximum bit rate, using advanced high-level modulation and coding techniques, that could be supported by a 6 MHz channel under signal-to-noise ratio assumptions discussed in section 3 below. The other principal part of the study considered video compression developments that would minimize the bit rate required to transmit a "full-motion" HDTV signal. Accordingly, the investigation considered transmission technology and video compression technology separately; this report is correspondingly organized into sections that discuss each technology. The conclusions discuss the joint implications of the findings of the individual sections.

2.0 Summary of findings

Current digital modulation techniques used in telecommunications transmission systems exhibit bandwidth efficiencies of several bits per second per Hertz of bandwidth. Under our interference assumptions, a bit rate of about 18 Mbps can be supported in a 6 MHz channel using well-proven techniques. Assuming that an uncompressed digital HDTV signal would be transmitted at a rate of about 1.2 Gbps, an overall compression ratio of at least 67:1 is necessary to allow transmission in the same bandwidth allocated for NTSC signals using our carrier-to-noise ratio and modulation format assumptions.

There are currently intraframe compression techniques that allow 30:1 ratios with apparently little detectable degradation in quality. Interframe compression is available that allows bit rate reductions of greater than 3:1. Assuming that these techniques can be applied more or less independently of each

Hatfield Associates, Inc.

March 20, 1989

other, the joint application of these techniques should result in a net compression ratio in the neighborhood of 90:1. This would allow the use of 6 MHz channels for transmission either over the air or via cable systems; sufficient spare bandwidth is available for forward error correction.

A successful reduced-bandwidth digital HDTV system clearly requires a well-coordinated enterprise involving participants from diverse fields. The fundamental components appear to be in place; an appropriate impetus could ensure the successful development in the next decade of bandwidth-efficient digital HDTV offering 35 mm image quality for consumer use.

3.0 Video compression

One generally assumes that HDTV systems will present images of 35 mm quality. The uncompressed bit rate for a digital HDTV signal is about 1.2 Gbps, according to several sources.¹ Various techniques exist to compress video signals to allow transmission in reduced bandwidths. Probably the most active area to date has been video teleconferencing, in which video signals are compressed for transmission at rates of 384 kbps and occasionally less. The compression techniques used for teleconferencing, however, do not generally offer good rendition of moving images.

Today, an NTSC signal requires a bit rate of about 90 Mbps without compression. Existing interframe coding techniques allow this rate to be reduced to 20 to 30 Mbps while still allowing "network quality."²

Intraframe coding can generally be applied independently of interframe coding, and compression ratios of 30:1 are currently available. Intel, for example, in its DVI (Digital Video Interactive) system that was developed by the Sarnoff Research Center³ and acquired by Intel from General Electric,⁴ achieves at least this degree of intraframe compression reportedly without noticeable degradation; Intel claims the reproduced signal is of the quality of one reproduced by VHS-format video tape.

¹See, e.g., Cable TV Technology, September 20, 1988, p 5.

²K. Feher, Advanced Digital Communications -- Systems and Signal Processing Techniques, Prentice-Hall, Inc., Englewood Cliffs: 1987.

³"IBM-TV?", Forbes, February 20, 1989, p. 74.

⁴"DVI May Be Programmers' Next Gold Mine," Electronics, February, 1989.

If the interframe and intraframe compression techniques are independent, then currently-available technology should allow a net compression of 90:1, with a resulting required bit rate of between 13 and 14 Mbps. Others have suggested that such rates are achievable. Workers at the Massachusetts Institute of Technology, for example, have stated that

"[t]he most complex receiver would depend on all of the techniques developed for highly sophisticated video conferencing systems. This implies a transmission rate of, perhaps, 10 Mbits/sec, which could readily be accommodated [sic] in an analog channel of a few MHz. This tradeoff between receiver complexity and channel efficiency shows that the former has a profound influence on TV system design. A system to be deployed in the 90's and to be used well into the next century should use technology appropriate to its era, and not to times past. This means, at the very least, a good deal of computational capacity, digital signal processing, programmability, and generous use of memory."⁵

The speed and computation power of microprocessors continue to grow at phenomenal rates. Microcomputers using Intel's 80386 processor have been favorably compared with the large IBM 360/50 mainframe machine of 20 years ago, and even more advanced devices have been announced by Intel and others. Furthermore, memory devices are decreasing in price per bit and are increasing in density, making it more and more economical to employ large quantities of memory in end-user devices, such as digital HDTV receivers.

Whether the compression techniques discussed in this section can be used together must be determined by competent investigators. However, it is reasonable to assume that sufficient knowledge exists in various areas to allow the 90:1 or so compression ratios that are required to reduce the raw digital HDTV bit rate to something under 20 Mbps. The information available to us suggests that these techniques can be applied to result in a highly-processed digital signal that will allow the reproduction of an HDTV image with little perceptible degradation. Progress in this area will continue to be made, and it seems quite safe to assume that, over the next decade or so, such compression ratios should be achievable without any perceptible degradation of static or moving images.

⁵W. F. Schreiber and A. B. Lippman, "Bandwidth-Efficient Advanced Television Systems," 1988 NAB Engineering Conference Proceedings, p. 410.

4.0 Digital transmission technology

Unlike cable distribution systems in which carrier-to-noise (C/N) ratios in the neighborhood of 50 dB can be sustained, the broadcast environment in the future may result in low carrier-to-interference levels (C/I) in fringe areas. In this study, HAI assumed that broadcast transmission will be interference-limited, and that C/N in such a system can be approximated by C/I. HAI further assumed that the worst-case C/I that must be handled will be about 12 dB and that 6 dB of antenna pattern interference rejection can be obtained for a net working value for minimum C/I (and hence C/N) of 18 dB.

Current digital transmission systems routinely exhibit bandwidth efficiencies of 4.5 bps/Hz. For example, digital long-haul microwave systems achieve this level using 64-level quadrature amplitude modulation (QAM). Systems using even higher-level (256 and 1024) QAM are either in service or are about to enter production; these offer bandwidth efficiencies of about 6 and 7.5 bps/Hz, respectively. The corresponding bit rates in a 6 MHz channel for these techniques range from 27 Mbps to 45 Mbps.

The penalty one pays for employing high-level modulation schemes is a reduction in the energy per transmitted bit and hence an increased bit error rate for a fixed carrier-to-noise ratio. For the problem at hand, either 16- or 64-level QAM is probably the most attractive of these techniques. For C/N = 18 dB, the E_b/N_0 for 64-level QAM is about 11.5 dB and is about 13 dB for 16-level QAM. Corresponding bit-error rates are about 2×10^{-2} and 2×10^{-5} , respectively.⁶

Because there has been little widespread experimentation with digital HDTV, there are no subjective testing results that indicate the acceptability to viewers of images degraded by a range of bit error rates. According to conventional voice communications practice, however, these error rates are rather high, and some form of forward error correction should be used. Furthermore, the fact that compression is achieved by the removal of redundant information suggests that errors may have a pronounced effect on the displayed image. We will therefore assume that an appropriate error-correcting technique will be required for the transmission of the compressed digital signal. A 33% overhead for redundant information seems reasonable to assume in the transmitted bit stream, using, for example, a rate 3/4 convolutional technique.

For broadcast transmission, then, it is reasonable to assume, under the conditions outlined in this section, that a

⁶D. R. Smith, Digital Transmission Systems, Van Nostrand Reinhold Company, New York: 1985.

6 MHz channel can support a bit rate of 18 Mbps using 16-level QAM. Thus, the compressed signal plus error correction overhead must result in a bit rate of no more than this value to be accommodated in a broadcast system using our C/I assumptions.

For the case of cable transmission, carrier-to-noise ratios are typically in the vicinity of 50 dB, and high-level QAM or other techniques will be usable at very low bit-error rates. Using 1024-level QAM, for example, would allow transmission of at least a 45 Mbps bit stream in a 6 MHz channel.

The modulation techniques discussed in this section are well-proven in practice and, as section 4 will show, appear to be perfectly adequate for the purpose at hand under our stated assumptions. However, there is much ongoing activity directed toward further improvements in the spectral efficiency of digital modulation formats. For example, such combined modulation and coding techniques as trellis-coded modulation can improve the efficiencies of older techniques by a few decibels. These improved techniques are in somewhat limited use today and will be available in improved form for implementation over the next few years.

5.0 Discussion and conclusions

A principal benefit of using digital transmission of HDTV signals is that it allows the use of digital processing techniques and devices. The rapid advances in the processing capabilities of microprocessors over the past decade are well-documented, as are the increases in memory density per device and the decrease in the overall cost of memory. Cheaper and denser memory facilitates economic frame storage in receivers and thereby allows the application of advanced interframe compression and expansion techniques.

In section 2, we noted that existing intraframe compression techniques allow ratios of around 30:1, with little noticeable degradation, leading to a reduced bit rate of about 40 Mbps. Other techniques for interframe compression have resulted in ratios of greater than 3:1. Under the assumption that intraframe and interframe compression can be performed more or less independently of each other, then it seems reasonable to conclude that a net bit rate of less than 18 Mbps, including error correction, should be within reach. Even if a factor of two or three were missing, one could justifiably expect that advances in image processing and compression techniques over the next few years would improve by at least such an amount.

Certainly, this data stream can be transmitted within a 6 MHz bandwidth using well-established digital modulation formats, as the discussion in section 3 has shown. This fact suggests, then, that broadcast transmission of digitized HDTV

signals is likely to be technically feasible within the existing states of the transmission and video compression arts. Obviously, suitable receiver circuitry must be developed that detects and corrects the received bit stream, expands the compressed information and converts it to analog form for display. One can expect, given the quantities one associates with consumer electronic products, that suitable digital processing and memory devices will be available at affordable prices over the next decade and very likely sooner.

Mr. BROWN. Now did you have an exhibit?

Mr. SIE. Yes, I do.

Mr. BROWN. Would you like to demonstrate that?

Mr. SIE. Sure. The exhibit basically shows one thing, which is called wide screen. We believe that is probably one of the best consumer frauds perpetrated on the American public and our engineering communities, because you have heard, "HDTV is always wide screen". So if we have a narrow screen, it is not as good. I would like to just show some facts.

Here is the same screen height that most of the demonstration you will see at shows, and in deliberations, the left side is our current standard. The world standard of 4x3.

Can we show the next? Now that is what you will see in the exhibits. That is the so-called "wide screen HDTV format." And it looks better. Most people will say, "Gee, that one is better." But we believe what the consumer really prefers is more area, because the 16x9 with the same height has 33 percent more area.

Let me have the next one. Now we can do just the reverse by taking a look at what happens if we use the same screen width. Now I am putting in the proposed so-called "sexy wide screen," HDTV 16x9. And I am going to offer you now the "tall screen version". Same width. Now the tall screen looks better. That is because I have cheated in the reverse direction, because now the tall screen with the same width has 33 percent more area than the 16x9.

The proper measurements should be same screen diagonal. That is how we sell TV sets. So you should use the same screen diagonals. And let's look at what those two look like. Well, it's kind of hard to tell, isn't it, which is better 16x9 or 4x3?

Here are some of the facts. The world standard 4x3 has 12 percent more area, because it is closer to a square. It has 22 percent more height, and it has 9 percent less in width. Now I submit to you, we shouldn't change and we must not change our standard for 9 percent increase in width.

That is sort of—in our opinion, that if we have the 4x3, nothing wrong with it. We can make it a lot cheaper. We can make it a larger screen, and it will be a lot more competitive, so that we don't have a forced obsolescence in our consumer market to change our TV sets.

Mr. BROWN. Thank you very much, Mr. Sie.

Mr. SIE. Sure.

Mr. BROWN. I am going to ask one question as soon as I can get Dr. Neuman's attention. Dr. Neuman, you have been very patient. You have sat through this and listened very carefully, and because I have high respect for your abilities as a synthesizer, I would like to ask you to just comment briefly on what you see as the points on which there is substantial agreement amongst those that you have heard this morning and what, if any, are the points on which you see there are fundamental differences amongst those witnesses that we have heard this morning.

Dr. NEUMAN. Well, Congressman Brown, you have been to many more of these hearings than I have, and I must—but from my experience in this domain, I must say that I was overwhelmed and very surprised at what I understood to be very strong unanimity and

support for an initiative of national scope and of significant financial size and breadth of involvement of companies from different industrial sectors, because in our era, there is a great constraint and restraint on the part of both Congressional leaders and leaders in the administration from doing anything to upset this idealized notion of a free marketplace.

A number of my colleagues and predecessors on the early panel had said, well, I usually don't say thing like this, but. And I think what you've heard loud and clear—and I think it was supported as well by the administration. And as you know, I have talked to Mr. Sikes repeatedly about this issue, that there comes a time when there is an issue which has the character that I believe these integrated high resolution systems have like Comsat before it and like radio as a generalized technology which evolved into broadcasting in the evolution of RCA and perhaps, as well, we get to see that in models like SEMATECH.

I noticed that your colleague, Congressman Dingell, yesterday at a speech, actually used the word "industrial policy." And I think his brave foray into actually addressing these questions is appropriate. Now I don't think it means that the government has to tell business what to do, and I would return to my own statement, which is that I think what we are exploring are new bases for joint efforts between government and industry. And the character of these joint enterprises hasn't been fully spelled out yet.

In Japan, with the leadership of NHK, there were 11 companies, and only 11 companies working on these projects. And NHK would dictate that a pair of companies, sometimes three or four, would work on a particular component of the high definition-system. That kind of directed coordination is very unlikely to work or be acceptable, I think, in the American community. I think, however, that the need for broader scale and scope and the need for the symbolic involvement of setting a structure such as RCA—I will note that in the fall of 1919, when RCA was set up, it was first set up as a paper corporation, and it was the involvement of industry leaders as they came to work with it and brought the financing and the technology, and very importantly, the patent pool, that RCA evolved into the important international corporation that it did, indeed, evolve into.

So I think you've gotten one very strong and supportive issue of support for initiative. It may take the form of Congressman Ritter's bill or some other form. Some people have expressed concern that the breadth of issues that the Ritter-Levine bill confront, lead it to be referred to so many committees that that may, in fact, slow it down, and I would refer to your expertise and your colleagues' expertise to find some way of dividing this issue up, perhaps to address the funding for NIST's advanced technologies program separately rather than an omnibus bill, that we might be able to achieve the speed and urgency that I think so many people have commended to you.

Mr. BROWN. All right. I appreciate those comments.

I am going to turn to Mr. Walker now, who plays a very important role on the committee. He is our genuine certified conservative who sets the benchmark for how far we can go in these things.
[Laughter.]

Mr. WALKER. Thank you, Mr. Chairman. I understand one of the panels sounded fairly supportive of the concept of using a royalty payment as a way, maybe of showing that government can cooperate, put up front money and then get paid back in royalties.

Would this panel generally agree with that kind of an approach as well?

Dr. McADAMS. Well, if you are asking me, I would say it is a very sensible approach. We note that in the Chrysler bailout, that the government had warrants on Chrysler stock and that resulted in some \$340 million profit back to the government. My understanding is that in most of the instances where the government has put its credit behind operations of this time that they have shown a significant profit. I see no reason why that should not continue.

If the government has a role to play, I think that industry should repay, so that the government has the ability to continue to pay that role.

Dr. NEUMAN. Perhaps we could tie the long-awaited Congressional pay raises to the additional income no doubt your wisdom will lead to.

[Laughter.]

Mr. WALKER. You want to really get yourself in trouble if you want to start tying those two together.

What about ideas such as government loan guarantees or interest rate buydowns at attractive rates instead of direct subsidies? Would that help?

Dr. McADAMS. I am an economist, so I love to answer questions like this. I say, absolutely. What I see is that, for example, in the case of the Semiconductor Industry Association and the American Electronics Association, they are hoping that they can have a three-way arrangement. That is, the producers of DRAMs, for example, are trying to arrange a consortium, not just with producers but also with users. The users, they hope, will be willing to put in some of the equity funds, so that the American firms that are mutually interdependent whether they like it or not, will become explicitly interdependent in this kind of an arrangement.

If the government then provides low interest loans and/or loan guarantees which can be repaid, as we have just said, out of profits of the operations, if there are profits, then I think that we have a very nice arrangement.

If the Federal Government, in this country, were to back its industry in the absence of worldwide antitrust legislation, we might not have any need for the government guarantee, if people know that the United States is serious and that we will compete at the commodity level, and that we recognize this as a national imperative in order for the survival of American electronics. Then I think that we would have a package that would work. This is one that if the people are really serious, if you are serious, if the administration is serious, it might cost essentially nothing.

Mr. SIE. May I comment? I think all kinds of support, as was described here today, really only has meaning if we know what we are supporting, I think it is very, very critical to make sure we analyze the whats before we do the hows, because—I can give you an example. If we support something that affects the American public in a detrimental fashion. It may work on one side, but some-

body else may come in on another. It is not like a commodity. This is a whole television system we are talking about. You don't want to support something that all of a sudden, the public television stations in Minot, North Dakota, can't use it. You have to look at what we want to do as a national policy to provide information, news and entertainment to the American public, which has the best system in the world. There is no system that has the ability to offer 30 to 40 channels, even in Japan or Europe.

So I think it is very important to know what we want to support before we discuss how. And I just want to add a word of caution in that regard.

Mr. WALKER. I think that is an important point. It leads me to another question that I had. SEMATECH has been referenced here by a number of people. That is but one example. There is another project that a lot of us on this committee are supportive of, aerospace flight, where the industry has gone together in a consortium to share technical developments on that. One of the important aspects of that though is that industry is putting up a lot of the up front costs, that about 50 percent of the monies that are going in have gone in from industry thus far. It seems to be one of the protections for exactly the kind of thing you are referencing, Mr. Sie, is to assure that there is some industry involvement in the financing up front too. That this doesn't become just a government subsidy program, because too often politicians, and even bureaucrats, make wrong decisions about how investment should go.

If people who are ultimately going to have to depend upon the end product are making some decisions that have some of their own money involved, we are likely to get a better kind of decision-making. So it seems to me that one of the things we may want to look at is some kind of a shared expense, so that we get the very best technology out of it.

Would anybody like to comment on that? Mr. Eastling?

Mr. EASTLING. Well, let me address it just with respect to the semiconductor industry. If you set up a system in which the government is funding 100 percent. Then what happens is people are good at bidding, end up making whatever it is that you are bidding on. So we would have Lockheed televisions or Lockheed DRAMs or whatever, because they are better at the process of responding to whoever it is that puts out the bid. I think we really have to avoid that. We want to build on the technological base we have and not start from scratch.

The people in the semiconductor industry, I am sure you know them. They wear cowboy hats and they are the archetypical entrepreneurs. It is just as amazing that they came to Congress as it is that Congress funded SEMATECH and but for the objection of some of the industry leaders, SEMATECH would have had a manufacturing element, but the people in the semiconductor industry recognize that the technology that goes into building a DRAM, that is the lithography, the shrinking of the chips, the clean rooms, is essential for the rest of the semiconductor manufacturing which they engage in and in which they are world leaders. Nobody touches Intel on a large area processing chip. Nobody touches Intel.

There are many other areas where the semiconductor industry leads.

So they are willing to put money into a DRAM facility, but if it is \$2 billion a year, and they have just lost \$3 or \$4 billion, which they have, they are not willing to do that. But what we need to do is to ask them to rise above their particular company interest. That is a very difficult thing for private industry in this country to do, but it is an areas where the semiconductors and DRAMs, in particular, where the industry is ready, where the model is in place, and it is, of course, crazy to have the manufacturing technology being developed and being dumped on the ground. I mean, there is no semiconductor manufacturing facility to take the \$250 million a year of technology that is being developed. That is a bit of an exaggeration, but without the DRAM centerpiece, you have no logical, cohesive plan.

So the point of how you fund it, it is clear to me that the industry would put up dollars for dollars. I don't think the royalty would work very well, whereas the royalty might work very well with some of the other panelists earlier in the day, who were developing new ideas, some new product.

We are talking in semiconductors and DRAMs particular, an old product, a commodity product, it goes in everything, and there is no return on investment.

Mr. WALKER. Well, just one follow-up point on that, though. I mean, it seems to me that your whole argument follows from the assumption that if we get HDTV, if you are going to get the purchase of the DRMS from American manufacturers, I mean, is that a logical assumption or won't the manufacturers go to old technology that is available to them in other countries as well, and go for the lowest possible cost, and we may not get them purchasing American technology anyhow. I mean, don't we run that risk as a part of all of this?

Mr. EASTLING. It is an excellent point. I happen to believe that you need an American content requirement for HDTV. That is a zero cost requirement, if you will—

Mr. WALKER. That gets us in trouble with GATT, doesn't it?

Mr. EASTLING. Well, not necessarily, no. There are exceptions under GATT that permit national content programs. And among those exceptions are infant industries, and we have two infants here. Each of them is an infant in part because of a long history of dumping. And I would like to point out that we are not going to stop dumping, unless we have equal market share in the dumper's market that they have in ours. And we are not going to have equal market share in someone else's market until we are in a position to trade market share back and forth. We can't do that. We have nothing to trade now. They have access to our market. We don't have access to theirs.

Mr. WALKER. Is that something we're going after though right now under the new trade bill? As I understand it, we are going after Korea as one of the best examples, that we are going after them, even as we speak.

Mr. MINETA. Will the gentleman yield on that score?

Mr. WALKER. Sure.

Mr. MINETA. Under the trade bill, under the super 301, we can designate countries that are practicing unfair trade practices, and I would assume that Korea and possibly Japan would be on that

super 301 list. I think that is fraught with potential in terms of the kinds of retaliatory action we could take, but I believe what Dr. McAdams is referring to is the semiconductor industry agreement, where we have an agreement that says within three years we will have 20 percent of their market in terms of their chip market. We are now two years into that agreement, and we are at 9.7 percent. We are a far cry from hitting 20 percent, and that is a three-year agreement.

Mr. WALKER. We are going to have a big third year.

Mr. MINETA. Absolutely. And that is why I just think we are smoking good stuff, when we think we are going to be able to depend on these things to get the market turned around for us. I appreciate my colleague yielding.

Dr. McADAMS. But what that says is, unless you can control your own market, you will not have access to their market. We do not control our market. Our market is the dumping ground, as Mr. Pearlman said, and we have to gain some control there.

I would like to respond to Mr. Sie's comment and that dealt with deciding what you want to do before you decide how you want to do it.

Well, there is one thing we have to do and we can't wait around for. And I would like to put that in the context of his comment about the digital video compression. If you do video digital compression, my understanding is, you have to do that with a lot of memory. There you are, ladies and gentlemen, you need the memory, no matter what you're gonna do. So one of the things you need, whether you do HDTV, digital compression, computers, microcomputers, you need the memory, and it seems to me that that is an area where we in our workshop identified the need for a consortium effort, and it will take substantial support from a committee like this one.

Without that support, John Eastling's comments apply. This industry is willing to put up money. This industry recognizes that they just lost billions of dollars when world oversupply occurred. There is nothing that we can do to stop world oversupply, because that is determined by who builds too much capacity when.

There is one thing we can do, and that is to assure that when the world is oversupplied, that U.S. firms come out the other side as effective competitors, despite the fact of the oversupply. If the Japanese lost \$4 billion to our \$2, they bought that market with their \$4 billion losses in DRAMs just a couple of years ago. \$4 billion as an investment to a future control over a large marketplace like DRAM is a good investment. \$2 billion with no return is a lousy investment. What we need to do is to take actions such that next time someone wants to lose \$4 billion they can do so, and it won't be an investment. We have to make that \$4 billion a loss.

Now I know no American private business that can do that. I know no American private business that can take \$2 to \$4 billion losses any time somebody wants to come and take over our marketplace. I think we, as a country, have to do that. And I also would like to point out that from my understanding, which comes from my students who work for IBM, in their memory activities, there were times in IBM's history, when its memory costs were 10 times the world market price, but IBM was a profitable organization be-

cause they were integrated, and they weren't selling memory. They were selling systems. Our problem is, that if we don't have our own memory manufacturers in this country, we may not be able to sell systems, because the memory can be used as a stepping stone up the food chain, past the pain, up the food chain. I got that from Jesse Jackson. And that would greatly disadvantage those higher margin areas.

But what we need to do is to recognize that we know there are some "whats" that we need to do with. And the question is when, and the answer to that one is clearly, now. The time is now, while we still have some capability in that business. The longer we wait out of that market, the greater the hurdle to return to that market. I think that is something that should happen this year, and I have it with good reason to believe that the industry would strongly support it.

Mr. WALKER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Scheuer.

Mr. SCHEUER. Well, it's been a very provocative hearing, and you've given us a lot to think about, all of you.

I was interested to hear Mr. Krall talk about the 50 percent of our graduate students in science, math and engineering, who are foreigners, and who go back to their own countries after they get their scientific and technical training.

How do you react to that? What is the remedy? What should we be doing?

Mr. KRALL. I think the remedy is very simple. If we have good jobs here, that percentage will shift very rapidly, just as it will—there are so many other linkages in our economy that will benefit by having a strong manufacturing economy. And it really comes down to policy. How do we put our finger on the scale to make it attractive to make things in the United States. We can do it in a couple of ways. We can do it by government grants, which is not our system, or we can do it by changing—in the end, we can divert capital to better uses. And how do we do that? I mean, capital is driven by the extremes of abject fear to greed, and so we can raise the greed factor by increasing the return for higher risk investments. Long term capital gains relief. And if you look at the capital gains rates and Dr. McAdams is probably a much more knowledgeable expert in this area than I am, I think you would find the U.S. is really confiscatory of all major nations in terms of its capital gains treatment.

So we really have signaled the capital community that it is much more attractive to go after an acquisition, tear down an old company, burn the furniture. You can make more money doing that than you can getting into HDTV. Therefore, there are no jobs for our science graduates. And therefore, our parents tell their children to study law, study medicine, study corporate finance. That is what we tell our kids to do. And so—we have excellent graduate schools. Dr. Neuman represents probably the finest technical school in the world, but how many Americans that want to go there can afford to go there? And why don't we have more schools like that? Well, we don't have enough jobs for our students.

So I believe this, again, is system and cause and effect, and we can talk about the symptoms or the causes, but that is my assessment of this gets fixed.

Mr. SCHEUER. Yes, Dr. Sie.

Mr. SIE. Yes. I am one of the few fortunate foreigners that took advantage of American education system and stayed, and I am very grateful to be able to do that.

Mr. SCHEUER. We are grateful you made that decision.

Mr. SIE. I think you have to look at the flip side. The flip side that is very encouraging, is that probably our collegiate and graduate school system is far superior than any other systems in the world. That is why we attract foreign students that come to this country. And I echo Mr. Krall, is that I don't think they can't get jobs. I do not believe that. And I think that the better minds are going towards the higher returns, the MBAs or the lawyers, because there seems to be⁴ a lot of emphasis in the United States on science and technology. Science and technology to me is a national resource, but somehow it doesn't really have as much glamor as a Donald Trump, for instance, you know. We used to like Einsteins. So we are losing that overall national psyche on the importance of science and technology, and without that, I don't think you have any economic, political or military power.

Mr. SCHEUER. How do you increase the attractiveness of science, technology and engineering as a career? What kind of a magnet do you offer?

Mr. SIE. Well, one of the things is pay them more money, if they are doing well.

Mr. KRALL. Create lots of jobs. That will drive up the wages, and it will take care of itself, and you will find a lot of people clamoring to go to MIT, and they will have to turn away students.

Mr. SCHEUER. Well, what's wrong with our corporate community that it isn't offering the kind of wages and salaries that would induce able young men and women to go into science and math and engineering?

Mr. SIE. Well, I guess I didn't suffer that problem when I went through the communications, the defense business and into a general management position, but I think that is a bigger issue of a question of double taxation, the dividend question. That is why you have the leveraged buyouts, which is a broader economic issue of the American economic system, that right now the double taxation, basically, of the dividend as well as the income on the corporation. I think many foreign countries do not have that, and I think it does not put us on a footing where we reward more of an equity formation and liquidation to optimize the return on investment of capital.

Mr. SCHEUER. Well, one of the reasons you have leveraged buyouts is because the taxpayer pays half of the cost of borrowing the money, and it makes it attractive for a corporation to borrow up to their eyeballs to pay for the leveraged buyout because the interest payments are deductible.

⁴Should read: not a lot of....

Let me ask, what do we have to do—is there a problem of inducing our best kids to get into science, math and engineering? Is there a problem that the kids that are coming from more modest families can't afford the freight, can't afford the cost of college graduate school, postdoctoral study?

Would we attract more and better students into science, math and engineering, if there were more government support for these studies? Any members of the panel. Is that a problem?

Mr. EASTLING. Let me address it this way. We have all just read about American children coming in thirteenth out of thirteen nations, internationally, in their primary and secondary school education. Part of the problem is our educational system is in deep trouble. It is very interesting that the—in my view, the major use of HDTV is in education. In other words, we kept hearing today, why would you want a clearer picture? And the answer is, nobody gives a damn about a clearer picture. It is that simple. What you want is multiple views related to the same subject. And that is what the HDTV potential really lies in. So you see the country's best lecturer on science in this window, and you see the problem sitting here. And you see the design, the airplane that he designed with those equations flying over here and being taken apart and rotated. That is what engineers are doing with HDTV today. And what we are talking about in this panel is bringing the cost of that work station down to the primary school level.

So HDTV, it seems to me, has its greatest impact in our society on the educational level of the children prior to the collegiate and graduate level we are talking about.

Mr. SCHEUER. I suppose what you are talking about is making kids, all kids, at a very young age, computer literate, so that they can naturally drift into science, math and engineering, if that is where their talents take them, and if they have financial access to college and postgraduate and postdoctoral science education.

Mr. EASTLING. I think that is exactly it. What we have done is amalgamate our educational system. We have permitted everyone to go through those primary and secondary schools, and we have lowered the level, and now we need to raise that level back up. And you need to do it by individual coaching, by one-on-one response. And the way you do that is through computer techniques. That is what the educational people will tell you, and the children have no trouble watching TV. They watch it six hours a day. They have no fear of computers. They are introduced to that at an early age. We need to just plug those things together, and if we are going to take a strategic initiative, it ought to be plug together HDTV with the educational system, so that somebody who shows and interest in an area can pursue it and can pursue it individually, because that facility is available to them, not in lockstep with other children.

Mr. SCHEUER. Thank you, Mr. Chairman.

Mr. BROWN. (presiding) Mr. Mineta.

Mr. MINETA. Thank you very much, Mr. Chairman. I really apologize for having missed the fine testimony being given by the panel, and I would like to, after the review of some of the statements, ask some questions.

First of all, Mr. Sie, I would like to ask about this whole issue of the medium or the spectrum that we have. You are with a cable TV company; is that what I understand?

Mr. SIE. That is correct.

Mr. MINETA. And I am wondering, if we were to compromise this in order to come up with some kind of a broadcast standard that is going to be acceptable, I am wondering whether or not, we aren't opting for second best in that choice.

Mr. SIE. Well, my belief is, we should have a robust debate on the doability, viability and effectiveness of a processed digital standard, which is a 6 MHz digitally based. And if after reviewing that, to find that there is no detriment in any aspect that we are talking about and still permit that 6 MHz for processed digital HDTV to very easily expand into broader bandwidth for close circuit application, for industrial applications, for medical diagnostic application. I mean, it is going from a volume base without suffering any detriments. And use that base to build other industrial uses of HDTV.

That is my belief. In the meantime, I believe that the same NTSC standard, EDTV, from a business risk point of view—I am not worried about any incompatible MUSE or Eureka system coming to our shores, if we have a EDTV system that is compatible. The main reason is because then all of the programming on ABC, CBS, NBC, HBO, Showtime, Discovery Channel, will be instantly available with high resolution 35 millimeter resolution to the consumer.

So you have the quickest way of getting a desirable product to the American public at the lowest cost. I am not worried that it takes me ten years to get the processed digital, if at the same time, we don't waste our spectrum or take time to deliberate what kind of standard that we should use. I say we shouldn't change the standard in the meantime. NTSC has served us well for 40 years. Let's not change a standard just for ten years more.

Mr. MINETA. Well, I am not a technician along this line, so I am really not that conversant, but we see ourselves being in a position of having HDTV that is either going to be satellite-compatible or cable-compatible.

Mr. SIE. What we want is also broadcast-compatible, because I think we have the most wonderful television system in the world, and let's not, you know, throw the baby out with the bathwater. It is very important that we have continuation of local broadcast station viability. Cable can penetrate maybe up to 70 percent of the American households in five to ten years, which means, still that 30 percent of the American public would have to watch television via broadcast (transmission).

I must say there is a question of this fiber national network that Congressman Brown talked about. To the best of my estimation, it is probably 30 years away, if at all.

Mr. MINETA. But just restricting it to the—what was it, the 4 MHz bandwidth—

Mr. SIE. Six MHz.

Mr. MINETA. Six MHz bandwidth. Doesn't that restrict the flexibility that we would otherwise have?

Mr. SIE. I do not believe so. And that is where the robust discussion should take place to see if we lose anything in terms of availability to the consumer, in terms of data manipulation. I don't believe so, if we have two entries into the TV sets with processed digital. And again, I say for any industrial application where you need maybe 2000 lines of resolution, that is a simple matter of just expanding that bandwidth, once you can accomplish that, and it is a leapfrog technology, so that we can get ahead of other existing current foreign competitive technologies.

Mr. MINETA. Mr. Eastling, I would like to ask about your 21st Century Technological Leadership Blueprint. I am wondering about the corporation that you envision in this operation. It seems to me we have—we have had a number of companies, TI, Motorola, who have been toying with the idea of maybe going and investing \$150 or \$200 million in their DRAM facilities. The problem is, if the Japanese reduce the cost of their DRAM by \$2, \$3, \$4, whatever it is, I mean, that \$200 million goes out the window.

I have had a number of conversations with these companies. Intel—when Intel won bought a piece of Micron, I thought, "Hey, Bob Noyce, are you going to go into DRAM?" "No, we're going to stay with ASIC." "Oh, okay." And you know, we get nowhere.

Now what is it about what you are proposing here that you feel is going to attract the kind of capital and the risk that a company would be willing to take, because of the fear that all the Japanese have to do or the Koreans would have to do is to reduce, let's say—they are not a major player but the Japanese are. They would just have to reduce their price a little bit, and bingo, there goes that investment they have made.

Mr. EASTLING. I think that is precisely why the semiconductor companies haven't made investment. If you look at \$4 billion investment last year by Japanese and \$2 billion by Koreans, and then you measure that against the \$150 million announced by Motorola, 150 by TI and 150 by Micron, you realize that in terms of—assuming they are equally efficient, that the shares of market that they are talking about going back into are very, very small. The Semiconductor Industry Association had on the table some \$600 or \$700 million that they were willing to put in. They realized that simply wasn't competitive. It wasn't enough money to develop the economy of scale, a plant of the size to compete with the Japanese and the Koreans. It seems to me, the combination of some reduction in the cost of capital that has to come from government funding.

Mr. MINETA. I take it that that comes from that 80—I was trying to look for it—that subsidy of that other 80 percent after the—

Mr. EASTLING. That is correct. What the mechanism is is not so important whether it is interest subsidy, direct capital funding, government-furnished equipment, as we did and still do in the aerospace industry, but the investment is uneconomic. In other words, nobody in his right mind, having just lost several billion dollars, would not put several more billion into the same business. So an American content program is another important part of the puzzle. The industry is willing to invest—that, I think, is a given—but to invest only because you have some fallout technology in your other chips is not a sufficient incentive for industry to invest

in DRAMs. Any investment in DRAMs is a zero-return investment. I mean, that is a real hard thing to say, a real brutal fact to look at. Invest \$2 billion a year for zero return on that \$2 billion a year.

A couple things come out of that. One is that in terms of international competition, the Japanese then understand, as Professor McAdams was saying, that they can't simply preempt American industry. They can't just take over a business and then enjoy the profits. You see, the profits that on DRAMs have been made by the Japanese manufacturers in the last two years are enormous. No American competition; very high prices; a demand which exceeded the supply.

So the payoff of driving out American competitors has been reaped by the Japanese. To get back in would mean an industry in which the Japanese competitors would also be losing money. In other words, you would create overcapacity in DRAMs, because the Japanese and Koreans are already making preemptive investments in DRAM capacity. They are building enough plants to supply our entire market, 100 percent of it. If we build a plant to supply our market, we would probably be building a third of the world capacity, and the world would then have one extra third of capacity. That would mean oversupply, low prices, nobody would make any money.

That is why the small tweaking of the system doesn't help very much. That is, let's cut the interest rate a little bit or put up \$30 million somewhere would just have no effect in this business.

But the SEMATECH program, I believe, is a successful program. I believe that a manufacturing program linked to it would attract industry into it. The same members would contribute, and they would contribute dollars on which they expected no return, because of the fallout in terms of the rest of their product lines and that the manufacturing technology which be employed in the DRAM plants.

Mr. MINETA. Do you think that there are enough good people, qualified people, to be able to run a TCA, given some of the problems that SEMATECH has already experienced and problems that MCC had? I am wondering whether or not, you know, we have that.

Mr. EASTLING. Well, I think that Bob Noyce is the Thomas Edison, the Albert Einstein of our time. I think he is the single most important person in the world in semiconductors, and I don't think there is a person in the business that would not go to work for Bob Noyce. He is that much of a gentleman, that much of a technical genius.

Mr. MINETA. The problem is that number two just left yesterday. [Laughter.]

Mr. EASTLING. Well, we don't know exactly what caused that, but he came with Bob, and sure, there is going to be turnover, and I accept the point, but with a leader like Bob Noyce, I think it makes it possible. That is why it took so long to fill the SEMATECH position. It is inherently—

Mr. MINETA. I think much to his credit. I think being partially having parented SEMATECH and after the great search for someone to try and make SEMATECH go and not being able to find

somebody, and Charlie Spork says to him, Bob, I think you've got to do it, and Bob is willing to say yes, at great sacrifice.

But the question is, do we have a lot of people out there in the industry to be able to say, TCA is a good way to go. How long is going to take to put it together? What about the financing? Do we have the people?

I think these are all questions that we ought to explore in some way, and I appreciate the thought you have given to putting this TCA approach together.

Well, again, let me thank the very, very fine panel for having been here, and I know that we are going to be able to continue to draw upon their breadth of experience and knowledge to help us formulate public policy.

Thank you very much, Mr. Chairman.

Mr. BROWN. Thank you, Mr. Mineta.

The entire day has been very constructive, and I think the members of this committee that have participated have been very greatly enlightened.

We are on this committee ourselves just trying to get up to speed, and each individual has a different stage of progress in this, and what you gentlemen have all done is help to give us a common background of understanding of the problem and what needs to be done.

I think that is a good sign for the possibility of action in the near future. We are very, very grateful to you, and we will continue to call on you for help. Thank you.

[Whereupon, at 3:00 p.m., the hearing was adjourned.]

APPENDIX I

I

101ST CONGRESS
1ST SESSION**H. R. 1267**

To stimulate the design, development, and manufacture of high definition television technology, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MARCH 2, 1989

Mr. RITTER (for himself and Mr. LEVINE of California) introduced the following bill; which was referred jointly to the Committees on Ways and Means, Energy and Commerce, the Judiciary, Science, Space, and Technology, and Government Operations

A BILL

To stimulate the design, development, and manufacture of high definition television technology, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE.**

4 This Act may be cited as the "High Definition Televi-
5 sion Competitiveness Act of 1989".

6 **SEC. 2. FINDINGS.**

7 The Congress finds that—

8 (1) the remote transmission of visual images his-
9 torically has been one of mankind's most important in-

1 ventions, and will increase in importance as the accu-
2 racy of those images increases and new consumer, edu-
3 cational, and industrial uses are developed;

4 (2) high definition television, or "HDTV", is a
5 radical improvement in television technology that will
6 change the way television is viewed and used;

7 (3) HDTV technology has diverse applications
8 which will make it increasingly important to the eco-
9 nomic well-being and security of the Nation;

10 (4) therefore, development of HDTV technology
11 by American industries is critically important to the
12 Nation's economy and security, and it is vital that the
13 Nation attain a leadership role and capability in the de-
14 velopment, design, and manufacture of HDTV and re-
15 lated technologies;

16 (5) the Nation's electronic manufacturing indus-
17 tries have virtually ceased to develop and manufacture
18 consumer electronics in the last decade, due to strong
19 competition in both domestic and world markets and
20 United States trade policies;

21 (6) offshore industries have successfully conducted
22 research and product development in a variety of
23 HDTV-related areas and have been highly successful
24 in the resulting commercial applications;

1 (7) government action and industry cooperation
2 are necessary to ensure that domestic industries
3 engage in long-term HDTV research and development,
4 and manufacture of HDTV products and related tech-
5 nologies; and

6 (8) it is necessary for the Congress to take the ac-
7 tions required by this Act to encourage and facilitate
8 the development and manufacture of domestically pro-
9 duced HDTV technologies.

10 **SEC. 3. DEFINITIONS.**

11 As used in titles II through VI of this Act—

12 (1) The term “Secretary” means the Secretary of
13 Commerce.

14 (2) The term “HDTV technology” means equip-
15 ment and techniques required to create, transmit, re-
16 ceive, display, process, record, store, recover, and play
17 back high definition television images and accompany-
18 ing sound material.

19 (3) The term “cooperative HDTV enterprise”
20 means any organization, joint venture, or partnership
21 of domestic designers or manufacturers (or both) of
22 broadcast or cable television technologies for the pur-
23 poses of—

1 (A) discussions, considerations, review, ac-
2 tions, or agreements concerning HDTV technolo-
3 gy;

4 (B) conducting research on, or design, devel-
5 opment, or manufacture of, HDTV technology; or

6 (C) any combination of the activities de-
7 scribed in subparagraphs (A) and (B).

8 **TITLE I—TAX INCENTIVES FOR RESEARCH**
9 **AND DEVELOPMENT.**

10 **SEC. 101. FINDINGS.**

11 The Congress finds that—

12 (1) incentives for long-term research and develop-
13 ment of HDTV technologies are essential for stimulat-
14 ing a domestic capability in this important field;

15 (2) the current Internal Revenue Code now elimi-
16 nates tax credits for industrial research and develop-
17 ment, which include credit for research, design, and de-
18 velopment of HDTV technologies;

19 (3) eliminating these tax credits has resulted in a
20 lack of incentives for domestic industries to engage in
21 HDTV-related research and development, with adverse
22 consequences for domestic capability to manufacture
23 HDTV equipment; and

24 (4) appropriate incentives for domestic industries
25 must be provided in the tax code to stimulate domestic

1 HDTV research, design, and development, including
2 pilot manufacturing of project working models.

3 **SEC. 102. MODIFICATION TO CREDIT FOR INCREASING RE-**
4 **SEARCH ACTIVITIES.**

5 (a) **GENERAL RULE.**—The following provisions of the
6 Internal Revenue Code of 1986 are hereby repealed:

7 (1) Section 4(g) (relating to termination).

8 (2) Section 280(c) (relating to disallowance of de-
9 duction of portion of research expenses).

10 (b) **EFFECTIVE DATE.**—The repeals made by subsec-
11 tion (a) shall apply to taxable years beginning after December
12 31, 1988.

13 **TITLE II—AUTHORITY TO ENGAGE IN JOINT**
14 **ACTIONS TO PROMOTE DEVELOPMENT**

15 **SEC. 201. FINDINGS.**

16 The Congress finds that—

17 (1) the efficient deployment of HDTV and HDTV
18 technologies will require significant cooperative efforts
19 by domestic companies;

20 (2) current statutory restrictions make it impossi-
21 ble for many companies now involved in research,
22 design, and development of HDTV technologies to co-
23 operate or to engage in joint ventures designed to fa-
24 cilitate domestic HDTV development and manufacture;
25 and

6

1 (3) cooperative efforts and joint ventures by do-
2 mestic companies must be encouraged to foster domes-
3 tic HDTV technology research, design, development,
4 and manufacture.

5 **SEC. 202. TREATMENT OF HDTV JOINT VENTURES UNDER THE**
6 **COMMUNICATIONS ACT OF 1934.**

7 Section 313 of the Communications Act of 1934 is
8 amended—

9 (1) by inserting before the period at the end of the
10 first sentence of subsection (a) the following: “, except
11 for activities conducted in accordance with subsection
12 (c)”;

13 (2) by adding at the end thereof the following:

14 “(c) The first sentence of subsection (a) of this section
15 shall not apply to any cooperative HDTV enterprise (as that
16 term is defined in section 3 of the High Definition Television
17 Competitiveness Act of 1989) engaged in a joint research,
18 development, or production venture with respect to which a
19 notification is in effect under section 6 of the National Coop-
20 erative Research Act of 1984 (15 U.S.C. 4305).”.

21 **SEC. 203. TREATMENT OF HDTV JOINT VENTURES UNDER THE**
22 **NATIONAL COOPERATIVE RESEARCH ACT OF**
23 **1984.**

24 Section 2 of the National Cooperative Research Act of
25 1984 is amended by adding at the end thereof the following:

1 “(c)(1) Notwithstanding subsection (b), the term ‘joint
2 research and development venture’ includes, with respect to
3 a cooperative HDTV enterprise—

4 “(A) discussions, considerations, review, actions,
5 or agreements concerning HDTV technology;

6 “(B) conducting research on, or design, develop-
7 ment, or manufacture of, HDTV technology; or

8 “(C) any combination of the activities described in
9 subparagraphs (A) and (B).

10 “(2) As used in this subsection, the terms ‘cooperative
11 HDTV enterprise’ and ‘HDTV technology’ have the mean-
12 ings provided in section 3 of the High Definition Television
13 Competitiveness Act of 1989.”.

14 **TITLE III—FEDERAL SUPPORT FOR**
15 **DEVELOPMENT INITIATIVES**

16 **SEC. 301. FINDINGS.**

17 The Congress finds that—

18 (1) cooperative efforts and joint ventures by do-
19 mestic entities in HDTV research, design, and devel-
20 opment will greatly stimulate increased domestic par-
21 ticipation in the HDTV industry;

22 (2) Government participation in and funding for
23 cooperative HDTV enterprise will ensure that these ef-
24 forts complement each other and facilitate a rapid in-

1 crease in domestic HDTV design, development, and
2 manufacture; and

3 (3) it is necessary for Congress to take the actions
4 required by this title to permit the Government to fa-
5 cilitate HDTV-related research, design, development,
6 and manufacture.

7 SEC. 302. AUTHORITY TO ESTABLISH PROGRAMS.

8 (a) GENERAL DEVELOPMENT ASSISTANCE.—The Sec-
9 retary shall, in accordance with the requirements of this title,
10 establish a program to provide general financial assistance to
11 cooperative HDTV enterprises to promote the discovery, de-
12 velopment, and commercialization of HDTV technology.

13 (b) SPECIAL ASSISTANCE FOR PILOT PROJECTS AND
14 DEMONSTRATIONS.—The Secretary shall, in accordance
15 with the requirements of this title, establish a separate pro-
16 gram to provide financial assistance to support pilot manufac-
17 turing projects and experimental community demonstrations
18 related to HDTV technology.

19 SEC. 303. APPLICATIONS FOR ASSISTANCE.

20 (a) COMPETITIVE SELECTION.—The Secretary shall
21 award financial assistance under this title competitively, on
22 the basis of applications from cooperative HDTV enterprises
23 containing or accompanied by such information as the Secre-
24 tary may require by regulation.

1 (b) CONSULTATION REQUIRED.—In determining
2 whether an application is likely to lead to productive lines of
3 research, development, or commercialization, the Secretary
4 shall consult with the Federal Communications Commission,
5 the National Telecommunications and Information Adminis-
6 tration, and other relevant Federal agencies. The Secretary
7 shall consult with the Secretary of State, the United States
8 Trade Representative, and other appropriate officials con-
9 cerning the impact on foreign trade and foreign relations of
10 the programs authorized by this title and the projects assisted
11 under this title.

12 SEC. 304. COOPERATIVE AGREEMENTS.

13 (a) GENERAL TERMS AND CONDITIONS.—The Secre-
14 tary shall not provide financial assistance to a successful ap-
15 plicant under section 303 unless the applicant enters into a
16 cooperative agreement containing such terms, conditions, and
17 assurance as the Secretary may require to carry out the pur-
18 poses and requirements of this title.

19 (b) SHARED FUNDING.—Each such cooperative agree-
20 ment shall provide that the Federal share of the cost of any
21 project or activity assisted under this title will not exceed
22 one-half of the cost of such project or activity.

23 SEC. 305. REPORTS.

24 (a) INTERIM QUARTERLY REPORTS.—The Secretary
25 shall submit to each House of the Congress and the President

1 interim quarterly reports on the state of progress of the re-
2 search, development, and commercialization assisted under
3 this title.

4 (b) COMPREHENSIVE REPORT.—The Secretary shall,
5 not later than 4 years after the date of enactment of this Act,
6 submit to each House of the Congress and the President a
7 comprehensive report on the results of the financial assist-
8 ance provided under this title. Such report shall analyze the
9 achievements and failures of the research, development, and
10 commercialization assisted under this title, and shall evaluate
11 the general applicability of the methods used to promote re-
12 search, development, and commercialization to other technol-
13 ogies. Such report shall include (1) an analysis of the effect of
14 HDTV technology on commercial broadcasting, (2) an analy-
15 sis of the impact of HDTV technology on the programming
16 industry, (3) an analysis of the extent to which HDTV tech-
17 nology would help United States companies compete in do-
18 mestic and foreign markets, and (4) an analysis of the poten-
19 tial use of lower cost HDTV technology in other products.

20 SEC. 306. AUTHORIZATION OF APPROPRIATIONS.

21 There are authorized to be appropriated to carry out
22 this title not to exceed \$100,000,000 for fiscal year 1990 and
23 each of the four succeeding fiscal years. Funds appropriated
24 pursuant to this section are authorized to remain available
25 until expended.

1 **TITLE IV—COORDINATION OF FEDERAL**
2 **PROCUREMENT OF HDTV TECHNOLOGY**

3 The Secretary shall, within 90 days after the date of
4 enactment of this Act, submit to each House of the Congress
5 recommendations for establishing a mechanism to coordinate
6 procurements of HDTV technology by the General Services
7 Administration, the Department of Defense, the National
8 Aeronautics and Space Administration, and other Federal
9 agencies in order (1) to secure lower unit costs by mass pur-
10 chase offers, and (2) to guarantee HDTV manufacturers sub-
11 stantial market potential to induce investment in research
12 and development.

13 **TITLE V—INTERNATIONAL TRADE**

14 **SEC. 501. RESPONSIBILITIES OF THE SECRETARY.**

15 The Secretary of Commerce shall, within 90 days after
16 the date of enactment of this Act, submit a report to the
17 President and the Congress on the implications for interna-
18 tional trade of HDTV technology. Such report shall include
19 such recommendations as the Secretary considers appropriate
20 on methods by which Federal laws governing international
21 trade may promote the development and viability of domestic
22 manufacturers of HDTV technology.

1 **TITLE VI—HDTV BROADCAST STANDARD**

2 **SEC. 601. ADDITIONAL FUNDS TO SUPPORT PROMULGATION**
3 **OF HDTV BROADCAST STANDARD.**

4 Section 6 of the Communications Act of 1934 is amend-
5 ed by adding at the end thereof the following: "In addition to
6 the sums authorized to be appropriated by this section, there
7 are authorized to be appropriated to the Commission
8 \$500,000 for fiscal year 1989 to enable the Commission to
9 prescribe a broadcast standard for high-definition television
10 transmission."

○

101ST CONGRESS
1ST SESSION

H. R. 1516

To improve the competitiveness of the United States domestic electronics industry and promote the introduction of high definition television products and services through a program of cooperative research and development.

IN THE HOUSE OF REPRESENTATIVES

MARCH 21, 1989

Mr. BROWN of California (for himself, Mr. MINETA, Mr. WALGREN, Mr. RITTER, and Mr. BOEHLERT) introduced the following bill; which was referred to the Committee on Science, Space, and Technology

A BILL

To improve the competitiveness of the United States domestic electronics industry and promote the introduction of high definition television products and services through a program of cooperative research and development.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE.**

4 This Act may be cited as the "High Definition Televi-
5 sion Research and Development Act of 1989".

6 **SEC. 2. FINDINGS AND PURPOSES.**

7 (a) **FINDINGS.**—The Congress finds that—

1 (1) maintaining a viable domestic electronics in-
2 dustry is vital to both the national security and the
3 economic well-being of the United States;

4 (2) the significant decrease in consumer electron-
5 ics market share held by United States companies has
6 led to the loss of United States leadership in designing,
7 developing, and manufacturing electronics products and
8 processes;

9 (3) the Federal Government can best facilitate the
10 development of new electronic products and technol-
11 ogies by promoting cooperative research and develop-
12 ment that assists domestic electronics companies in
13 solving generic technology problems, and by emphasiz-
14 ing technology transfer within the domestic industry;

15 (4) high definition television is a cutting edge con-
16 sumer electronics technology which offers markedly su-
17 perior video display, and is estimated to become a
18 \$20,000,000,000 industry by the mid-1990's;

19 (5) development of high definition television prod-
20 ucts and services will drive the advancement of other
21 segments of the consumer and military electronics in-
22 dustry such as semiconductors, flat screen displays,
23 manufacturing, telecommunication, microprocessors,
24 and software;

1 (6) Japanese and European investments in high
2 definition television exceed \$1,000,000,000 as their
3 government-coordinated consortia race to bring high
4 definition television products and services to the mar-
5 ketplace;

6 (7) United States high definition television re-
7 search is fragmented and less market-oriented than
8 overseas consortia who, with government support, can
9 rapidly transform research into products; and

10 (8) private sector cooperation with the Federal
11 Government can improve domestic high definition tele-
12 vision research and development.

13 (b) PURPOSES.—The purposes of this Act are—

14 (1) to improve the competitive position of the
15 United States domestic consumer electronics industry
16 by supporting research and development into technol-
17 ogies which have substantial economic and national se-
18 curity potential; and

19 (2) to assist in the establishment and funding of
20 one or more joint research and development ventures
21 in high definition television through the Advanced
22 Technology Program at the National Institute of
23 Standards and Technology.

1 SEC. 3. ESTABLISHMENT OF PROGRAM.

2 (a) ASSISTANCE.—The Secretary of Commerce, acting
3 through the Director of the National Institute of Standards
4 and Technology, shall provide assistance as necessary under
5 section 28 of the Act of March 3, 1901, for the creation and
6 support of one or more joint research and development ven-
7 tures (hereafter in this Act referred to as “joint ventures”) to
8 identify and solve generic technology and manufacturing
9 problems in high definition television research and develop-
10 ment so as to speed commercialization of high definition tele-
11 vision products and services, and to establish procedures for
12 technology sharing and technology transfer among members
13 of the joint venture while protecting against transfer of intel-
14 lectual properties, trade secrets, or proprietary data overseas.

15 (b) FEDERAL REGISTER NOTICE.—The Secretary of
16 Commerce, acting through the Director of the National Insti-
17 tute of Standards and Technology, shall, within 120 days
18 after the date of enactment of this Act, publish notice in the
19 Federal Register stating that the Institute is prepared to
20 accept applications for assistance under this Act. Such notice
21 shall include a description of joint ventures eligible for assist-
22 ance under this Act, and maximum assistance levels expected
23 to be available for joint ventures under this Act.

24 SEC. 4. MEMORANDUM, REPORT, AND OPERATING PLAN.

25 (a) MEMORANDUM.—The Secretary of Commerce,
26 acting through the Director of the National Institute of

1 Standards and Technology, shall negotiate a Memorandum
2 with the participants of any joint venture selected for assist-
3 ance under this Act, delineating the activities and responsibil-
4 ities of each member of the joint venture as required by this
5 Act. Each such Memorandum shall be delivered to the appro-
6 priate committees of Congress within 180 days after the se-
7 lection of the joint venture.

8 (b) ANNUAL REPORT AND OPERATING PLAN.—Each
9 joint venture receiving assistance under this Act shall submit
10 an annual report and operating plan to the Secretary of Com-
11 merce, the appropriate committees of Congress, and the
12 Comptroller General of the United States which—

13 (1) describes, and modifies or proposes modifica-
14 tions to, as appropriate, the short and long term goals
15 of the joint venture, and the allocation of resources to
16 accomplish those goals;

17 (2) describes the financial reporting and auditing
18 procedures to be implemented by the members of the
19 joint venture;

20 (3) summarizes the technology accomplishments
21 and applications of research results within the preced-
22 ing year toward the short and long term goals de-
23 scribed under paragraph (1);

24 (4) summarizes the technology transfer agree-
25 ments among members of the joint venture;

1 (5) summarizes the advice of the Visiting Commit-
2 tee on Advanced Technology received and considered
3 by the joint venture during the preceding year; and

4 (6) summarizes the results of any audit of the
5 joint venture conducted during the preceding year.

6 **SEC. 5. INTELLECTUAL PROPERTIES.**

7 Section 28 of the Act of March 3, 1901, is amended by
8 adding at the end the following new subsection:

9 “(f) All intellectual properties, trade secrets, and techni-
10 cal data developed by a joint venture receiving assistance
11 under this Act shall be treated as if they are inventions made
12 with Federal assistance under chapter 18 of title 35, United
13 States Code.”.

14 **SEC. 6. AUTHORIZATION OF APPROPRIATIONS.**

15 There are authorized to be appropriated to the Secre-
16 tary of Commerce for the purposes of this Act, \$100,000,000
17 for each of the fiscal years ending September 30, 1990,
18 1991, 1992, 1993, and 1994.

○

APPENDIX II

IT.

35 TECHNOLOGY DRIVE, BOX 4915, WARREN, NEW JERSEY 07060 • (201) 668-5000 • TELEX: 510-600-5741 • FAX: (201) 668-5068

April 5, 1989

The Honorable Robert A. Roe
2243 Rayburn House Office
Washington, D.C. 20515

Dear Congressman Roe:

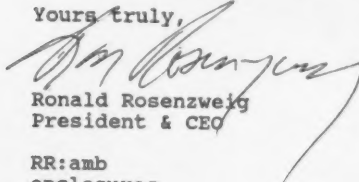
I would like to thank you and the Science, Space and Technology Committee for the attention and warm reception extended to our panel at the recent HDTV hearing. Your enthusiasm and activism will go a long way to helping the United States retain its rightful role as a leading producer (not just consumer) of advanced consumer electronics. As you rightfully commented, this issue is not just about another "box" but rather about global leadership in high technology industries.

I thought you and your staff would be interested in this enclosed article by ICE on The Korean Miracle. It clearly outlines the strategies used and results obtained for the Korean economy by having government "seeding" and partnering with commercial industry. This report capsulizes the competitive environment faced by U.S. companies in the global marketplace for television and semiconductors. Note that the major CHAEBOLS are in both semiconductor and consumer electronics.

I am also enclosing for your interest a white paper I authored for the American Electronics Association called "Blueprint for AEA Policy". If you or your staff have any questions regarding the enclosed material, please do not hesitate to contact me. I am more than happy to be of assistance.

In closing, let me say that as a fellow New Jerseyman, I was truly impressed with your committee leadership and hope that it leads to success in funding NIST for HDTV development.

Yours truly,



Ronald Rosenzweig
President & CEO

RR:amb
enclosures

cc: Pat Hubbard, AEA



Covering the Semiconductor Industry

Managing Editor
William J. McClean

THE KOREAN MIRACLE: FIRE IN THE EAST

Small power
house

Korea has recently emerged as a major electronics and semiconductor supplier capable of challenging (in some product lines) both U.S.-based and Japanese-based companies. In 1988, South Korean companies sold nearly \$1.5 billion worth of semiconductors. This is quite an achievement for a country roughly the size of Indiana with few natural resources and limited arable land.

*≈ 5% of World Market:
≈ 15% of US sales*

Government help

South Korea's prominence in semiconductors did not happen by accident or overnight. Since the late 1960's, the South Korean government has actively fostered the growth of the electronic industry through favorable laws, low interest loans, and the establishment of an electronics research and development organization, the Korean Institute of Electronics Technology.

Work habits

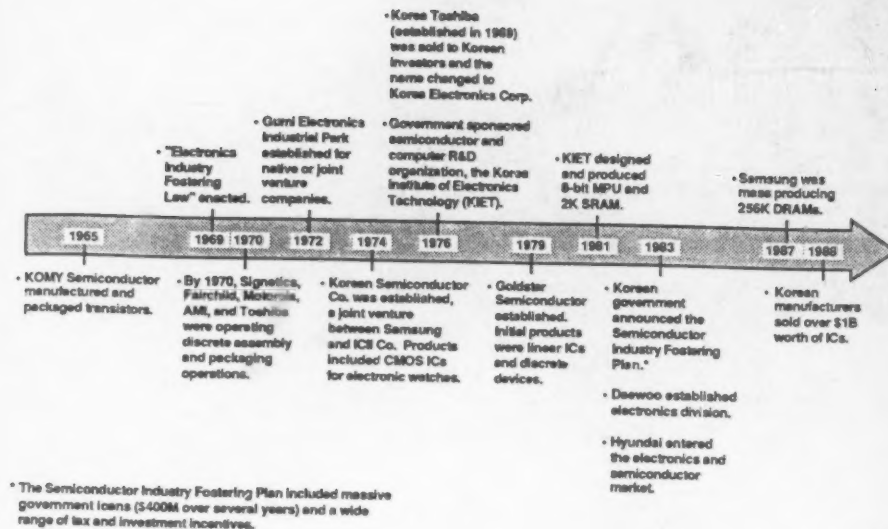
Besides government assistance, another key ingredient of the South Korean success story is the hard work ethic and determination of the Korean people. One political pundit summed up the tenacity of the Korean character by defining a Korean pacifist as a person who tolerates a differing point of view only when knocked unconscious. Perhaps a more fair evaluation describes South Koreans as trying to accomplish in five years what it took the Japanese twenty years to achieve.

Beginnings

At any rate, the favorable business and governmental climate initially attracted major semiconductor firms to set up packaging and assembly facilities in South Korea. Some of these firms were Signetics, Fairchild, Motorola, AMI, and Toshiba. The first indigenous IC producer was established in the mid-1970's to manufacture CMOS ICs for electronic watches. The company was called Korean Semiconductor Company and was a joint venture between Samsung and ICII Company. By 1983, Korea Electronics Corporation, Goldstar, Hyundai, and Daewoo were also producing ICs in South Korea (Figure 1).

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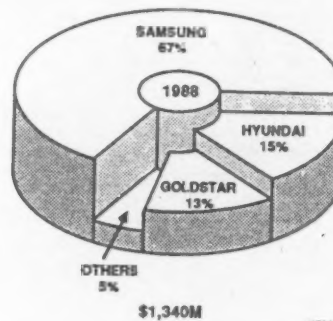


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Figure 1. Timeline of the Korean Semiconductor Industry

Giants

Today, semiconductor production in South Korea is dominated by Samsung, Hyundai, and Goldstar. These firms account for 90 percent of the total Korean companies' IC sales (Figure 2).



11726C

Figure 2. Korean IC Sales

Company sales

Korean semiconductor sales for 1987 and 1988 are shown in Table 1. Because the Korean currency more closely follows the U.S. dollar than does the yen, the 156 percent increase in 1988 sales is reasonably representative of actual growth.

COMPANY	1987			1988 (EST)			1988/1987 PERCENT CHANGE
	IC	DISCRETE	TOTAL	IC	DISCRETE	TOTAL	
SAMSUNG	292	35	327	900	88	988	192
HYUNDAI	40	—	40	290	—	290	400
GOLDSTAR	115	5	120	180	10	190	58
OTHERS	37	53	90	60	70	130	44
TOTAL	484	93	577	1,340	135	1,475	156

11725C

Table 1. Korean Semiconductor Sales (\$M)

*Silicon - small
percentage*

Although semiconductor growth in South Korea can only be described as explosive, actual silicon sales represent only a fraction of the total sales for Samsung, Hyundai, Lucky-Goldstar, and Daewoo (Table 2). This is due to the South Korean corporate structure or "chaebol" system. Chaebols are huge vertically integrated firms that make everything from soap to jet engines.

COMPANY	1987 TOTAL REVENUES (\$M)	1987 NET PROFITS (\$M)	1987 RETURN ON SALES (%)	1987 SEMICONDUCTOR SALES (\$M)	1987 SEMICONDUCTOR SALES AS A PERCENTAGE OF TOTAL REVENUES	MISCELLANEOUS
SAMSUNG	23,800	183	0.8	327	1.4	Involved in food processing, textiles, insurance, medical instruments, semiconductors, and electronic systems Only Korean firm to be operating fab in U.S. (San Jose, CA)
HYUNDAI	20,200	191	0.9	40	0.2	Involved in automobiles, shipbuilding, construction, semiconductors, and electronic systems Abruptly closed Santa Clara fab in 1985
LUCKY-GOLDSTAR (INCLUDES GOLDSTAR SEMICONDUCTOR LTD.)	14,300	198	1.4	120	0.8	Oldest consumer electronics conglomerate in South Korea Building large fabrication facility in South Korea Involved in electronic and chemical products
DAEWOO	11,100	3	0.02	NA	NA	Involved in foreign trade, construction, electronics, machine industries, ship building, chemicals, and textiles Fastest growing electronics firm in South Korea

Note: Net profits may be under-reported by Korean companies for tax reasons.
748 Won = \$1.00

13638

Table 2. Portrait of the Top Four Electronic Korean "Chaebols"

INTEGRATED CIRCUIT ENGINEERING CORPORATION

Deep pockets

Starting in the early 1980's these chaebols essentially bought their way into the IC and discrete market by channelling profits from other areas (e.g., textiles, shipbuilding, autos, and electronics) into semiconductor fabrication and packaging facilities. The cost of participation in any high technology field is not cheap especially if a company has little prior knowledge or experience in the new area. For example, in both 1984 and 1985 South Korean semiconductor-related capital expenditures were over \$500 million while semiconductor sales were only \$119 million and \$214 million, respectively (Figure 3).

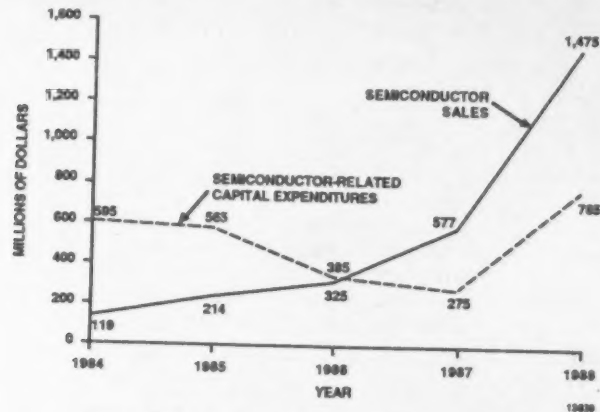


Figure 3. Korean Semiconductor Sales and Capital Expenditures

The rest of this article will examine in detail the history and recent events at the top electronic chaebols.

Samsung*Biggest firm*

Samsung is considered to be the largest South Korean company. In 1988, Samsung's 37 companies employed approximately 150,000 people worldwide and recorded sales of over \$30 billion. This sales level would put Samsung in the top 20 of the Forbes 500 list.

Japanese connection

Similar to many of the Japanese manufacturers, Samsung is a vertically integrated electronic system house. This is not a coincidence as Samsung's founder, B.C. Lee, was educated in Japan and frequently conferred with top executives from Matsushita and Honda.

Employee school The degree to which Samsung has adopted Japanese business practices is shown by its \$22 million annual investment in the Samsung Education and Training Center. The Center, modeled after Matsushita's employee school, promotes teamwork and loyalty over individualism. All new employees spend at least an entire 24 hour day at the center with refresher courses mandatory.

Watch chips As touched on earlier, Samsung formed the first indigenous Korean IC manufacturing company in 1974 to produce watch chips. Since then, Samsung has quickly moved down the learning curve with perhaps the best achievements accomplished in 1988 with production of fast 256K SRAMs and 1M DRAMs.

Facilities Samsung's primary semiconductor production complex is in Kicheung, South Korea but it also operates fabrication facilities in San Jose, California and Buchon, South Korea (Table 3). The third fab in Kicheung came on stream in the fall of 1988 and fab 4 is currently under construction with production planned for late 1989. In line with Samsung's general strategy these two new fabs will produce commodity memories, 1M DRAMs, and eventually 4M DRAMs.

LOCATION	PRODUCTS	COMMENTS
San Jose, CA	PLDs, FIFOs, A/D converters, smart power devices, MPU peripherals, ASIC memory	• PLD design, development, and fabrication is primary emphasis • Headquarters for all of Samsung's U.S. operations • Capacity is 1.5K wafers/week • Class 1 CMOS fab line • 300 semiconductor R&D personnel
Kicheung, South Korea	256K and 1M DRAMs, SRAMs, EPROMs, EEPROMs, ASICs	• Kicheung is one of the largest semiconductor complexes in the world • Fab 3 recently completed and will be dedicated to 1M DRAMs • Fab 4 under construction with production slated for late 1989 • Product mix 1H88: 70% DRAMs, 15% EPROMs and EEPROMs, 10% SRAMs, 5% ASICs • Total capacity ~13.6K wafers/week • 1,000 semiconductor R&D personnel
Buchon, South Korea	Telecom products, logic devices, power MOSFETs, high voltage transistors	• All package development takes place at Buchon • 800 semiconductor R&D personnel

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Table 3. Samsung's Semiconductor Facilities

Goals Not only does Samsung want to be the number one 256K DRAM supplier and one of the top five 1M DRAM vendors, it also has a stated goal of being the one-stop shop for all system house needs. Samsung is already firmly entrenched in memory and standard logic markets and is quickly moving into gate arrays and PLDs.

NCR agreement Two yet untapped areas are 32-bit microprocessors and standard cell devices. Even here Samsung is quickly acquiring expertise. Reportedly, Samsung is looking for a 32-bit RISC MPU second-sourcing agreement, possibly with Sun Microsystems (SPARC) or

Intergraph (Clipper). In the standard cell area, Samsung has recently signed a far reaching agreement with NCR. As part of the pact, Samsung acquires NCR's 1.5 micron and 2 micron standard cell library in addition to ASIC design tools. In exchange Samsung will provide foundry service, SRAM technology, and perhaps most importantly, access to the Southeast Asian market in Korea, Singapore, and Hong Kong.

Knowledge acquisition

The strategy of acquiring technology has paid off well for Samsung. Through alliances, Samsung has gained expertise in DRAMs, EEPROMs, MPUs, MCUs, CMOS logic, and power MOS products (Table 4).

PARTNER	PRODUCT/TECHNOLOGY
MICRON	54K AND 256K DRAM
MOSTEK	256K DRAM
EXEL	16K EEPROM
INTEL	MPU, MCU, AND PERIPHERALS
IXYS	POWER MOSFET
NCR	STANDARD CELLS

T 38-45

Table 4. Key Samsung Licensing and Technical Agreements

DRAM royalties

There have been some serious setbacks in Samsung's drive to be a major semiconductor producer. In one of the few legal cases instigated by a Japanese company, Hitachi sued Samsung over patents on memory products. Samsung settled the suit and is now paying royalties. In other legal action, Samsung petitioned the U.S. courts to strike down the AMD/MMI patents on PLDs. AMD quickly countersued and the case is now in court. Also, Samsung briefly had a distribution pact with Arrow that would have greatly increased its exposure in North America. After only two weeks, Arrow's major U.S. suppliers forced Arrow to drop Samsung.

Bright future

Despite these problems, Samsung should remain the strongest South Korean semiconductor vendor. As long as the memory market (primarily DRAMs) remains healthy, Samsung should do well. However, in the event of a severe semiconductor slump, Samsung will be sitting on significant excess capacity.

Lucky-Goldstar

Western Electric assistance

Goldstar ushered in the Korean electronics industry in 1959 by assembling vacuum tube radios with imported components. Twenty years later, with the help of a technology transfer from Western Electric, Goldstar established Goldstar Semiconductor and begun to produce linear ICs and discrete devices for internal consumption in consumer electronic products. In 1983, the Lucky and Goldstar groups merged to form Lucky-Goldstar.

U.S. technology

In order to move into the minicomputer, mainframe, and telecommunication systems markets, Goldstar actively sought integrated circuit technology from U.S. semiconductor firms. These alliances (Table 5) allowed Goldstar to gain expertise in DRAMs, SRAMs, and MPUs.

PARTNER	PRODUCT/TECHNOLOGY	MISCELLANEOUS
AT&T	64K DRAM	Agreement signed in 1983. Production started in 1984.
Zilog	Z-80 8-bit MPU	Second-source agreement signed in 1983.
LSI Logic	Gate array	From 1984 to 1986 Goldstar sold \$100M worth of wafers to LSI.
Fairchild	64K CMOS SRAM	Agreement signed in 1985.

13857

Table 5. Key Goldstar Licensing and Technical Agreements

256K SRAMs

Although Goldstar has historically concentrated on ASICs and bipolar logic, it is now pushing into the commodity memory business. Both 256K and 1M DRAMs are in volume production at the company's fabrication and packaging facilities (Table 6). SRAMs are also important to Goldstar's memory strategy. Moreover, fabrication of 256K SRAMs is slated for the first half of 1989.

FACILITY	LOCATION	MISCELLANEOUS
Semiconductor Fabrication	Anyang, Kyunggi Province (25 miles south of Seoul)	• A total of 4 fab lines Two lines: 100mm wafers bipolar fab One line: 125mm wafers 2μ MOS fab One line: 125mm wafers 1.2μ MOS fab
Semiconductor Packaging	Gumi Industrial Complex (300 miles southeast of Seoul)	• Total employment at Anyang and Gumi Industrial complex is 2,000
Goldstar Central Research Laboratory	Seoul	• Dedicated spring of 1987 • 820 on staff • In-house R&D lab specializing in design and pilot production of semiconductors • Other areas of study include consumer electronics and office automation

13858

Table 6. Goldstar's Current Semiconductor Facilities

Massive spending

Any doubts of Goldstar's intentions to become a major memory vendor were completely swept away by the recently released details of a proposed IC fabrication and packaging complex. If the eight-year plan is fully realized, the Goldstar Cheongju Complex will have a

price tag of \$2.2 billion and have an annual IC production of DRAMs and SRAMs valued at \$3.47 billion. The total square footage of the facility is expected to be 2.7 million sq. ft., which is roughly equivalent to a rectangular building 1/2 mile long and 1/5 mile wide.

\$400M in sales

The complex will be built in three stages with the first stage to be completed in 1991 at a cost of \$650 million. Total capacity of the first stage is estimated at 40K 150mm wafers/month and should generate \$417 million per year in sales. Figure 4 details all three stages of the Cheongju Complex.

OVERVIEW:

- 1988 - 1990 investment = \$2.2B
- Total facility area = 2.7 million square feet

FIRST STAGE (Completion scheduled for 1991):

- Investment = \$650M
- Proposed annual IC production = \$417M (\$250M in DRAMs, \$167M in SRAMs)
- Capacity = 40K 150mm wafers/month

SECOND STAGE (Completion scheduled for 1993):

- Investment = \$735M
- Proposed annual IC production = \$1.66B (\$1.1B in DRAMs, \$560M in SRAMs)

THIRD STAGE (Completion scheduled for 1995):

- Investment = \$805M
- Proposed annual IC production = \$3.47B (\$2.08B in DRAMs, 1.39B in SRAMs)

SUMMARY:

- Goldstar is targeting \$4.44B in total semiconductor sales in 1997, estimated to be 3.7% of the worldwide market.

12804

Figure 4. Goldstar's 3-Stage IC Facility Plan (Cheongju Complex)

Gamble

These massive and nearly unprecedented financial commitments put the world on notice that Goldstar is positioning itself to be a major semiconductor power through the end of the twentieth century and into the twenty-first century. However, many European and American semiconductor executives believe that Goldstar may be moving too fast too quickly and predict highly leveraged under-utilized facilities.

Hyundai

New entrant

The Hyundai group differs from Samsung and Lucky-Goldstar in at least one important way. Hyundai, long recognized for its construction work, shipbuilding, and auto manufacturing did not have an electronics division until 1963. At that time the chairman of Hyundai, Chung Yu Jung, targeted semiconductors and electronic systems as crucial to the long-term growth of the company.

Poor timing

Hyundai quickly embarked on an expensive and ambitious plan by constructing a production facility in Ichon, South Korea and an R&D/pilot line fab in California. Unfortunately, by the time all the facilities were in place, the semiconductor boom was over and the 1985 recession had begun.

California mistake

The Santa Clara, California pilot plant, known as Modern Electrosystems, succeeded in designing, developing, and producing a 16K SRAM but was abruptly closed in late 1985. Meanwhile, the main production facility in South Korea had ample unused capacity.

TI

Hyundai management responded to these setbacks by concentrating on foundry work and licensing agreements (Table 7). Perhaps the most important of these is the foundry/technology exchange with Texas Instruments. In this arrangement TI provides a wealth of technical resources (including process engineers) to assist Hyundai in ramping up and maintaining its 256K DRAM line. This acquired knowledge should prove invaluable when Hyundai begins volume production of 1M DRAMs sometime in 1989.

PARTNER	PRODUCT/TECHNOLOGY	MISCELLANEOUS
General Instrument	EPROM and EEPROM	1.5µ CMOS process
International CMOS Technology	64K EEPROM	Hyundai invested in ICT
Imasec	256K DRAM	---
Pyramit Computer	RISC MPU	---
Texas Instruments	DRAM	Significant foundry deal included technical assistance from TI
Vitalic	16K, 64K SRAM 256K, 1M DRAM	Hyundai unable to meet production deadlines. Vitalic turned to Taiwanese foundries.

1988

Table 7. Key Hyundai Licensing and Technical Agreements

Chip factory

At least for the foreseeable future Hyundai should have no capacity constraints. Its huge fabrication facility in Ichon, valued at \$350 million, can produce over half a million wafers per year (Table 8). In addition, another mammoth facility is being built on an adjacent site.

Mixed results

Although Hyundai has made a substantial monetary commitment to semiconductors and electronics, visible successes have been few and far between. In fact, Hyundai Electronics, in four of the five years of operation, did not show a profit. Hyundai officials can only hope their patience and fortitude (and deep pockets) will shortly payoff.

FACILITY	LOCATION	MISCELLANEOUS
Hyundai Electronics Industries (Total of 3 divisions details are below)	Ichon, Kyunggi Province	Total employment = 3,800
Division I	Ichon, Kyunggi Province	Capacity is 250,000 125mm wafers/year
Division II	Ichon, Kyunggi Province	Capacity is 300,000 150mm wafers/year
Division III	Ichon, Kyunggi Province	IC assembly and final test

13867

Table 8. Hyundai's Semiconductor Facilities

Daewoo*Buying in*

The Daewoo Group is made up of thirty companies involved in a myriad of activities that include consumer electronics, shipbuilding, construction, banking, finance, and insurance. In 1983, Daewoo entered the electronics market by acquiring the semiconductor operations and electronic portion of Taihan Electric Wire Company. One year later Daewoo briefly attempted to acquire the Korean Institute of Electronics Technology but eventually withdrew its offer.

Captive function

The primary function of Daewoo's semiconductor effort is to support its consumer electronics division. In the U.S. Daewoo is best known as the manufacturer of a popular IBM PC clone, Leading Edge. In 1988 Daewoo shipped half a million personal computers to Leading Edge Products, Inc., based in Canton, Massachusetts. According to ICE's definitions, Daewoo would be classified as a captive semiconductor producer.

ASIC attempt

Through its affiliate Zymos, Daewoo is trying to establish a presence in ASICs by setting up a design center in Seoul (Figure 5). Originally, Zymos was acquired in 1986 and maintained its own fabrication facility in Sunnyvale, California until early 1988. At that time the facility was sold to Saratoga.

FACILITY DESCRIPTION:

\$1M merchant ASIC Design Center located in the Semiconductor Division of Daewoo Telecom Co.

DESIGN TOOLS:

Zymos ASIC software

TECHNOLOGY:

1.5µ CMOS with plans to develop 1.2µ CMOS

MARKETS:

Targeting South Korea, U.S., and Japan

EMPLOYEES:

15 designers from the U.S. and Japan

Sources: Korea High Tech Review/ICE

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Figure 5. Daewoo Zymos Semiconductor Design Center

INTEGRATED CIRCUIT ENGINEERING CORPORATION

2nd tier player

Daewoo is a very successful consumer electronics house and though it may venture into ASICs, the company, at least in the near future, will not be a major merchant IC vendor.

Conclusion*Significant planned investments*

The combination of massive investments, active government support, generous technology exchanges, and an impressive work ethic has created, in a relatively short time period, a formidable high technology industry in South Korea. Moreover, as indicated by the proposed 1989 semiconductor-related capital expenditures (Table 9) the electronic chaebols do not intend to rest on their laurels. It should be noted, however, that large capital investments do not necessarily guarantee success.

COMPANY	1988 (\$M)	1989 (\$M)	PERCENT CHANGE 1989/1988
SAMSUNG	512	585	+14
GOLDSTAR	73	366	+401
HYUNDAI	120	366	+205
DAEWOO	37	47	+28
TOTAL	742	1,364	+84

Source: Korea High-Tech Review

13650

Table 9. 1988 and 1989 Korean Semiconductor-Related Capital Expenditures

New attitude

Other contributing factors that built up the South Korean electronic and semiconductor houses appear to have changed. For example, U.S. electronic companies now view South Korea as a major threat second only to Japan. In addition, protection of intellectual property, especially in the semiconductor area, is being rigorously pursued by American, Japanese, and European firms. In the future, the South Koreans will be required to shoulder more of the responsibility of developing and fostering new technologies, ICs, and electronic systems.

Dice roll

The most immediate problem facing the Korean electronic firms is their dependence on the worldwide economy, especially the U.S. As shown in Table 10, most of the total IC production is exported, leaving South Korea very vulnerable to any softness in demand for ICs or electronic systems. Although the product diversification inherent in the chaebol structure provides some protection, even a mild recession could leave Samsung, Goldstar, and Hyundai footing the bill for massive empty IC fabs. Only time will tell if the Korean gamble will pay off.

COMPANIES	PRODUCTION MONTH	COMMENTS
Samsung	5.5M 256K DRAMs 1.5M 1M DRAMs 300K 64K DRAMs 100K 256K DRAMs	• 68% of DRAM production exported • 76% of SRAM production exported • Of total exported ICs: 40% sent to U.S. 30% sent to Europe 30% sent to South East Asia 10% other (includes Argentina, Brazil, and Japan)
Goldstar	400K 16K SRAMs 50K 64K SRAMs	• 80% of SRAM production exported (most to U.S.)
Hyundai	1.5M 16K SRAMs 1.2M 64K SRAMs 6M 256K DRAMs	• Of total SRAM production: 40% sent to Asian countries 25% sent to U.S. 20% sent to Europe 15% sold within Korea • Of total DRAM production: 60% sent to U.S. (TI main customer) 10% sent to Asia and Europe

Source: Korea High Tech Review

12880

Table 10. Sampling of Korean Production (January 1989)

ICE
 INTEGRATED CIRCUIT ENGINEERING CORPORATION
 15022 N. 73rd Street • Scottsdale, Arizona 85260-0478
 Telephone: 602-988-9780 • Fax: 602-948-1885

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The Korean Miracle: Fire in the East 1
 (Scott L. Hudson)

BLUEPRINT FOR AEA POLICY

By Ronald Rosenzweig

August 1988

The discussions that took place at the HDTV meeting have caused me to coalesce my thoughts on the leadership role AEA should take in electronics policy generally and HDTV policy specifically. The central thoughts stem from an analysis of the impact of defense spending on industrial economic growth during the post WWII period. This analysis leads to specific proposals for AEA to consider regarding electronics and HDTV policy.

BACKGROUND

I have been involved in the development of state-of-the-art semiconductor technology for the past 25 years. During this period it is my observation that U.S. leadership in high technology in general, and electronics specifically, has been driven in large part by the requirements of the Department of Defense in order to achieve our national security goals. The stringent requirements of defense applications have led to early developments in semiconductors, integrated circuits, lasers, sensors, satellite communications, miniaturized electronics, signal processing and many other technologies that later became commercial products. Those technologies have been underwritten through direct funding from a substantial portion of the DoD budget. The DoD budget has consumed approximately 6% of U.S. GNP during most of the post WWII period and now totals about \$300 billion per year. To put this in perspective, the entire U.S. electronics industry is 2/3 the size at \$200 billion.

Throughout the 50's, 60's and 70's the spinoffs from DoD funded technology has nurtured the U.S. electronics industry and created many great new business opportunities. However, starting in the mid 70's and rapidly increasing during the 1980's, a new industrial entity - Japan, Inc. - has become a world economic force and is now challenging the U.S. for economic leadership. What differentiates Japan from the U.S.?

There are many ways to look at this problem and many variables to consider, but in this thesis the point of view is "How do countries view their national security interests?".

JAPAN MODEL

In my view, Japan has perceived their national security - their "SURVIVAL" as a nation - as being linked to their ability to be a world economic power. This view has been greatly underwritten by the U.S. position (based on post WWII mentality) that Japan should not re-arm. Thus, the quid-pro-quo for Japan not rearming is that the U.S. would protect Japan. Therefore, acting under that security umbrella, Japan has spent less than 1% of GNP per year on defense during this same period. Think about it - a 5% of GNP differential every year for 40 years. Every 15-20 years the U.S. spends the equivalent of its annual GNP on defense while it takes Japan more than 100 years.

How has Japan used this "extra" 5%/year? They have used it to develop an industrial complex that efficiently manufactures products with high technology content for the world market. As an isolated island nation with high population density and limited resources to sustain that population, Japan has used high value added, high technology products as a weapon to become a world power. They have not invested in state-of-the-art electronics technology for electronic warfare but rather for consumer electronics warfare so that now they "dominate" the world consumer electronics market. The result is economic power and thus international power.

U.S./SOVIET CONFLICT

The U.S. and USSR policy during this same period has been that defense supremacy is the #1 priority for being a world power. The Soviet Union has spent, in their paranoia, greater than 10% of their GNP on defense and have, as a result, reduced their economy and standard of living to third world levels. It is only recently with

new young leadership that, through "Glasnost", the Soviet Union is facing up to its economic disaster. It is important to note that the first action taken by the new Russian leadership has been to reduce military tension and reduce the arms build-up. This, in my view, is creating a fantastic window of opportunity for the U.S. to rebuild its industrial base in order to regain world economic leadership. This can be accomplished by redirecting a portion of defense spending to industrial development spending.

In the past 40 years the U.S. has been fighting a war on two fronts, and, as Napoleon learned, that's a hard way to win. By fighting and funding a war against Communism and the U.S.S.R. on the defense front and against Japan and Western Europe on the economic front, our great nation has suffered economic decline. Our currency is devalued. We have become a larger debtor nation than third world countries. We are selling productive assets to foreign countries to gain liquidity. We require foreign investment to finance our debt.

EUROPEAN MODEL

A word on Europe. Our major trading partners and allies in Europe have done fairly well in this post WWII period. Through NATO, defense spending has been reasonably orchestrated. The major European countries have spent approximately 4% of GNP on defense, approximately 2% less than the U.S. but substantially more than Japan. Through the Common Market, the European economies have become interlocked (and by 1992 will be even more so), and they have used consortiums and strategic alliances to effectively promote the growth of their economies through high technology. Witness the Airbus - a strong competitor to Boeing and McDonnell Douglas; the Concorde, the only SST in operation; and projects like Eureka, RACE, etc. West Germany, for example, has invested almost \$1 billion to create a 200 MPH train system. West Germany and Japan are now competing to put a high speed train system between Los Angeles and Las Vegas. The U.S. will pay \$1.7 billion to install this foreign-made train system.

The European countries, in general, are more nationalistic and use this in areas such as telecommunications, which are government controlled, as a way to selectively protect their markets and support their internal industry. It is, for example, pretty difficult for U.S. or Japanese communication equipment to get into the French or German PTT. Call it a matter of National Security.

So there you have it - four different models vying for economic leadership. The conclusion is obvious. The combination of low defense spending and some trade protection is winning the economic battle against a high defense spending policy.

	<u>Defense Spending</u> <u>% of GNP</u>	<u>Trade Policy</u>	<u>Economic</u> <u>Strength</u>
U.S.	6%	Open	Declining
Japan	< 1%	Protected	Growing
Europe	4%	Selectively protected	Stable
U.S.S.R.	>10%	Isolated	Disaster

DEFENSE SPENDING

A word about Defense Spending, a very controversial subject. A strong defense in our present world climate is a necessity to ensure the security of our nation and to help maintain our standard of life. Defense spending is also a driver for the development of new technology. However, much of defense spending is non-productive economically, and I would argue - and this is key - that technology developed for the purpose of developing your industrial and economic strength (as in Japan) is more efficient for the economy than technology developed for defense applications. Therefore, if two economic powers are in competition, the most efficient will win. In my view, in the past 30 years the U.S. economy has benefited substantially from the by-products of defense technology while Japan has benefited even more effectively from the directed products of its technology. So while the U.S. has developed semiconductors through

DoD sponsored VHSIC and DARPA programs, Japan has developed 4MB DRAMS for MITI sponsored consumer and computer projects. I would argue that when it comes to ECONOMIC COMPETITION the Japanese model is more likely to produce a winning result.

SO WHAT DO WE DO NOW?

Fundamental to my proposals for AEA are the following:

- Economic competitiveness is now the National Security issue
- A second rate economic power can not be a world leader
- Government is not the enemy of business, but a business partner in this new global economy.
- The U.S. should treat economic competitiveness like they treat national security - approximately 1% of GNP should be allocated to fund major U.S. programs to improve our economic and technology infrastructure.

COMPETITIVENESS

I believe the AEA should advocate a course that raises U.S. economic competitiveness to #1 priority for the next administration. The true value of SEMATECH as a construct is not that it might save the semiconductor industry, but that it recognizes that the health of a high technology commercial industry is critical to the security interests of the U.S. I believe the AEA can build on that to develop an association course of action. Economic leadership has to be the #1 U.S. priority.

I recommend a few positions in that regard:

- Department of Commerce should be raised to equal stature with State and Defense Departments. That means they should become a funding agency to promote industrial competitiveness.
- The Executive Branch should have a "National Competitiveness Advisor" equal in stature to the National Security Advisor. A person such as David Packard would be an ideal candidate.
- National Competitiveness policy should have as its goals the creation of new industries, the support of existing industries, and the re-entry into key lost industries such as consumer electronics. The methodology would be to create major new initiatives (such as the Space program) to drive advanced technologies. Examples are:
 - 1) R&D support for new technologies such as super conductors, super computers and artificial intelligence that will create new industries:

Example of a Government program

- establish a new 300 MPH railroad system based on superconductivity by the year 2020 (commit \$1 Billion)

- 2) Nurture and support our leading industries such as:
 - computers
 - software
 - communications

Example of a government program

- a government sponsored program with the goal of connecting every home in the U.S. to a wideband network by the year 2010

- 3) Regain our position in critical lost industries such as consumer electronics

Example

- Develop a national manufacturing initiative for producing consumer electronics in the U.S. (a MINITEL like effort)

These programs, funded jointly by industry and government, will lead to a national economic renaissance. One percent of U.S. GNP is more than \$50 billion. Think of the economic impact if \$50 billion were invested by the U.S. government in refurbishing our industry! In creating a national HDTV network, a 300 mile, ~~per~~ superconductor train system, Robots with artificial intelligence, we could reclaim lost industries and create new ones. Think of the jobs created and the wealth created by such an economic renaissance.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550



OFFICE OF THE
DIRECTOR

March 28, 1989

Honorable Robert A. Roe
Chairman, Committee on
Science, Space and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I wish to provide you with the status of relevant NSF activities for the record of your March 22 hearing on High Definition Television (HDTV). The Foundation currently conducts no programmatic research specifically focused on advanced television technologies. However, several of the basic research areas the Foundation does support could have implications for HDTV, such as:

- o Data compression, reconstruction and storage techniques;
- o Signal processing and conversion;
- o Multi-media human computer interaction; and
- o High capability display systems.

The Foundation made awards in these research areas totalling about \$750,000 in Fiscal Year 1988.

Specifically focusing on HDTV, NSF is funding a study through our Japanese Technology Evaluation Center of the comparative status of Japanese and U.S. high definition television activities. A number of U.S. experts are participating in this analysis. A final report is anticipated in approximately six months. We would be pleased to provide you copies as soon as the report is available.

Secondly, NSF technical staff are participating in evaluation of proposals recently received by the Defense Advanced Research Projects Agency (DARPA). These proposals are in response to a DARPA request for proposals for high definition display research and development. While the funding and decisions for the proposals reside in DARPA, our staff will continue to cooperate with and monitor their activities.

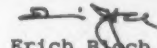
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Division of Science, Space
and Technology

Finally, the Foundation's 1989 Small Business Innovation Research (SBIR) program solicitation will include opportunities for small high-technology firms to submit proposals related to HDTV research. The solicitation also identifies HDTV as one of five areas of growing national importance.

Please contact me if you desire further details regarding any of these basic research activities conducted by NSF which could relate to HDTV.

Sincerely,


Erich Bloch
Director

cc: Honorable Robert S. Walker



UNITED STATES ACTIVITIES

Promoting Career and Technology Policy Interests of Electrical, Electronics & Computer Engineers

United States Activities Board

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Information Policy
Committee on Man & Radiation
Defense R&D
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April 7, 1989

Mr. Robert E. Whittington
Acting Administrator
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Mr. Robert A. Mosbacher
Secretary of Commerce
U.S. Department of Commerce
14th Street & Constitution Ave., NW
Washington, DC 20230

Gentlemen:

I am writing to voice concern over the recently publicized plans of the FAA to award a \$1 billion contract to a Japanese television manufacturer for advanced radar screens, or high-resolution displays, for the U.S. air traffic control system.

As you are aware, the U.S. electronics technology base is in a situation of crisis. The advent of high definition television (HDTV) presents both an opportunity and a challenge to this country to regain a competitive edge in consumer electronics, an industry that the U.S. has lost to foreign competitors. From experience we have learned that the absence of a U.S. owned base in consumer electronics has resulted in compounding problems, including the absence of U.S. design and manufacturing capability, which deprives us of spillover benefits into other industries that have military and civilian implications.

The magnitude of the proposed FAA purchase of foreign-owned HDTV technology could create serious disincentives for the U.S. industry as they work to develop HDTV systems to compete with foreign manufacturers. We understand that the foreign-owned manufacturer under consideration is sub-contracted by an American-owned firm, however, this is immaterial, since the technology involved is foreign.

In order to give U.S. industries the opportunity to develop a competitive technology, the rapid delivery requirements of the FAA should be reconsidered.

Positive U.S. government policies are absolutely critical to assure that the U.S.-owned firms can become reestablished in vital sectors of the electronics industry. We urge the FAA to reconsider this purchase, in favor of purchasing U.S. technology that should be available in the proper timeframe for the FAA's upgrading plans.

IEEE-USA, 1111 - 19th Street, N.W. Suite 608, Washington, DC 20036-3690

The Institute of Electrical and Electronics Engineers, Inc.

The IEEE-USA is closely following the issues related to high definition television (HDTV), which has included convening a workshop to bring the concerned parties together to develop a U.S. strategy for HDTV, and testifying before Congress. I have enclosed several of our recent positions on HDTV for your review. Please feel free to call on the IEEE-USA should you have any questions. I thank you for your consideration of this vital matter.

Sincerely,

Edward C. Bertnoll

Edward C. Bertnoll
Chairman, IEEE-USA

cc: Carla Hills, U.S. Trade Representative
John Sununu, White House Chief of Staff
Representative Robert Roe, Chairman, House
Science, Space, and Technology Committee
Representative Edward Markey
Representative Don Ritter



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Promoting Career and Technology Policy Interests of Electrical, Electronics & Computer Engineers

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EXTENSION OF REMARKS OF
ALAN K. McADAMS
ON BEHALF OF THE
TECHNOLOGY ACTIVITIES COUNCIL
OF THE
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/
UNITED STATES ACTIVITIES
ON
ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE
BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
MARCH 22, 1989

IEEE-USA, 1111 - 19th Street, N.W. Suite 608, Washington, DC 20036-3690

The Institute of Electrical and Electronics Engineers, Inc.

EXTENSION OF REMARKS
of
ALAN K. McADAMS
on behalf of the
TECHNOLOGY ACTIVITIES COUNCIL
of the
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/
UNITED STATES ACTIVITIES
on
ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE
before the
Committee on Science, Space, and Technology
United States House of Representatives
March 22, 1989

The following remarks serve as an extension of the testimony presented by Alan K. McAdams on March 22, 1989, before the House Committee on Science, Space, and Technology, at their hearing on "Advanced Television Systems--Regaining The Competitive Edge."

The extended statement makes the following points:

- The United States' electronics technology base is in a situation of crisis. To meet the crisis, the IEEE-USA proposes a national initiative and the creation of three consortia to begin to revitalize the U.S. electronics industries.
- The causes of the problems faced by the U.S. electronics industries and the interrelationships among these problems are complex and multifaceted. Solutions must meet the complexities of the real problems.
- The advent of High Definition Television (HDTV) provides an opportunity and a challenge for U.S. owned firms to reestablish leadership in the consumer electronics market in the U.S. with technologies that are crucial for both military and civilian use. The IEEE-USA recommends the creation of three industry-led consortia in such dual-use technologies as next steps toward this goal. These consortia are:

<u>Consortium</u>	<u>Industry Leader</u>
1) HDTV (High Definition Television)	AEA (American Electronics Association)
2) DRAMs (Dynamic Random Access Memories)	SIA (Semiconductor Industry Association)
3) HRS (High Resolution Systems)	(Not yet Identified)

By implementing these consortia, the U.S. can begin to reverse the current downward spiral and begin to revitalize the U.S. electronics industrial base.

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- U.S. government policies in support of these consortia are absolutely critical to assure that U.S.-owned firms can become reestablished in vital dual-use sectors of the electronics industry. IEEE-USA has identified and endorsed the first steps; these steps must be taken NOW!
- Such consortia do not represent a panacea. However, their creation would represent a profound change in U.S. policy toward its industrial base and that would provide an important signal to U.S. trading partners.

The rationale presented in support of these conclusions is:

- Currently conditions in the U.S. domestic markets are not hospitable to American-owned firms that produce television and related dual-use technologies. Even when an American-owned firm can be a low-cost producer of products of high quality, it cannot stay in business because of strategies that are rational for its foreign competitors, but destructive for U.S. firms.
- The U.S. is vulnerable when American-owned firms lack capacity to produce critical dual-use components. This has been the case with dynamic random access memories (DRAMs)--currently in short supply--which are an essential component of computer systems, military systems and many consumer electronics products, including advanced televisions.
- The U.S. computer industry faces a serious challenge from the Japanese. Because the Japanese control close to 90% of the world's production of DRAMs for the merchant market, they have the ability to price their computers and other products far below current levels. Should the Japanese choose to do this, many U.S. computer and other high-technology manufacturers would be at a severe competitive disadvantage.
- U.S. supercomputer firms are especially vulnerable to Japanese competition because they are essentially stand-alone, non-vertically integrated companies that must rely on other entrepreneurial firms or on their Japanese competitors for semiconductors and other critical components.
- The Japanese economy is structurally different from the U.S. economy and from the economies of all other industrialized nations. This difference has meant that U.S. electronics firms--especially those that produce dual-use technologies--are at a substantial disadvantage when they are in competition with firms from Japan even in the U.S. market. The U.S. cannot expect the Japanese to change an approach to their economy which is rational for them and has proven to be so successful for them. Therefore, the U.S. must deal domestically with factors that it can control if U.S. firms are to survive in domestic and world competition with the Japanese.

The U.S. must take action now to create these consortia and must provide support sufficient to assure their success.

Introduction

The analysis below presents some important facts about two market places in the United States with implications for military and civilian needs: that for consumer televisions and related products, and that for dynamic random access memories (DRAMs). The important conclusions from the analysis of these market-places is that under current conditions of world trade, these U.S. markets are not hospitable to U.S.-owned firms even when those firms achieve low costs and world-class quality.

There are structural reasons which help to explain why the U.S. market is relatively unattractive to U.S. producers. A main reason is that many foreign producers that compete in the U.S., operate from relatively secure home markets in which they earn the bulk of their profits. (That is, they use their home markets as the source of the bulk of their profits and the U.S. markets to gain overall scale economies). It is economically efficient from their viewpoint to operate in this fashion. A specific example in relation to Korean manufacturers of color television sets is used to illustrate the different incentive structure which these foreign firms face, and the implications of that incentive structure for U.S.-owned manufacturers in the U.S. market.

Next, evidence is presented that shows that the Japanese economic system is truly different from the economic systems of other industrialized economies. This evidence is of two kinds: first, a series of recent economic studies establishes some key differences in the ways in which the Japanese economy performs as compared to the economies in other countries; and, second, anecdotal material which for years has been consistent with the hypothesis that Japan's economic structure is "different." The recent studies thoroughly document and reinforce these anecdotal examples.

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- Because the Japanese approach is so successful for the Japanese, and because it is so different from our own, we must come to grips with the following imperatives:

- First, we cannot expect the Japanese to function the way we would in their position.

- Second, we must recognize that there are few incentives for the Japanese to change.

- Third, we therefore have little alternative but to deal domestically (with those factors which currently are under our control) to redress the imbalances which result from the interactions of our two very different economic systems.

The three consortia recommended by the IEEE-USA workshop and currently in the process of being established, represent early steps in this redress. If we are successful in creating such consortia, which will permit U.S.-owned manufacturers to perform profitably in global markets under current conditions of competition, then we will have achieved the first steps toward the goal of reestablishing U.S. industrial presence in dual-use electronics technology areas.

The Significance of HDTV

The advent of high definition television presents both an opportunity and a challenge to this country. We have the opportunity to reestablish the U.S. position in consumer electronics. From experience we have learned that the absence of a U.S.-owned base in consumer electronics has resulted in compounding problems. For example, recent innovations in consumer electronics such as VCRs are almost all imported from abroad. The fact that the products of these industries must be imported adds to our trade imbalance. Further, the absence of the U.S. design and manufacturing capability in these areas has deprived the U.S. of spill-over benefits into other industries that have both military and civilian implications. Under today's conditions, approximately one third of all the DRAMs produced in the world are used in consumer electronics products.

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Japanese forecasts suggest that by the turn of the century, two thirds of the DRAMs produced in the world will be used in consumer electronics products. The remaining third will be used in products including computer systems of all types. Under such conditions, the revenues from consumer electronics could well defray the cost of R&D for future generations of products as well as for the production facilities of all the DRAMs that are produced. In the higher technology areas, this could then imply that DRAMs would be essentially a "free good." The implications of such power in the hands of others for U.S.-based computer manufacturers are rather dismal to contemplate. More is said about this problem below.

Facts About the Market for Color Television in the U.S.

In the mid 1980's a study done for General Electric showed that GE's costs were substantially above those for a number of others in the industry and that therefore it would be desirable for GE to purchase its color TV sets from someone else for distribution by GE. General Electric chose to subcontract to Matsushita for the manufacture of television sets for sale under GE's label. Shortly thereafter, General Electric acquired RCA in one of the largest corporate mergers in history. General Electric then commissioned the same consultants to study the total manufacturing facilities of the combined organization. In mid 1986, the consultants reported back with a strategy to make RCA a low-cost producer of color television sets and with majority domestic U.S. content in its sets.

Based on this information, General Electric shifted the production of its television sets from Matsushita to RCA and began to implement the strategy, achieving considerable success. The consultants concluded that the devaluation of the U.S. dollar contributed little to the net gain that was achieved. Nonetheless, despite these gains, the fact that the quality of its

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RCA-brand TV's were favorably rated in relation to those of Sony, especially for picture quality, the prices of RCA sets were substantially less than those of Sony. (See table below.) GE found that the color television business in the United States was not sufficiently attractive for GE to remain in the business.

Comparison of Quality Ratings
and Prices
RCA vs SONY Color TV Sets
Screen Sizes 13-27, From 1-84 to 6-88

Date of Rating	Screen Size	# of Sets Rated	RCA Rating	SONY Rating	RCA Price	SONY Price	SONY Price As % RCA
1-84	19"	18	7	8	\$730	\$730	100%
1-86	25"-27"	18	4	5	\$800	\$1250	156%
3-87	20" Stereo	20	15	1	\$499	\$700	140%
3-87	19" Mono	19	11	13	\$299	\$412	138%
6-88	13"	18	10	6	\$250	\$350	140%

Note: The box indicates the higher rating of the two.
Source: Consumer Reports - For dates indicated.

The new strategic approach was shared with Thomson, the French company that purchased GE's TV business. The new strategy significantly enhanced the price that GE received from the sale. Despite the success of the new strategic approach (scheduled for completion this year), Thomson Consumer Electronics has yet to claim in its reports to the U.S. Trade Commission that its U.S. operations are profitable. That this is the case in the market for color televisions in the United States, is indeed disturbing.

Why then, you might ask, would anyone wish to sell color televisions in the United States? If low-cost producers are unable to be profitable operating in this market, why would anyone stay? Yet the market is served with color television. What explains this?

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While preparing this testimony, an interesting coincidence occurred. A case being analyzed in one of the author's classes happened to involve a Korean manufacturer of color television sets. The analysis of that case provides a partial answer to the above rhetorical question. The incentives to the Korean manufacturer were different from those of American manufacturers.

As is true in a number of oriental societies, there is a favorable public reaction to the largest domestic producer of a given product. The largest domestic producer is viewed by the domestic population as being "the best." This was true of the Korean firm in question. Some 80% of Korean consumers surveyed, rated firm one's color TV's as the best Korean sets. (The fact is that as of the time of the case, the firm's product was rated 18 of 18 listed; and, "significantly lower in quality," than the first 15 sets in the above-referenced ratings--see the table on page 6 for source.)

Firm one was the largest Korean producer of color television sets. As such, its television sets were able to command a significant premium in the home market--largely in response to this cultural assumption relating market penetration and quality of product. In any case, as of 1984, the date of the case in question, this firm (and a number of Taiwanese firms) had just been adjudicated by the U.S.'s International Trade Commission, to be "dumping" its products in the United States. That is, essentially identical products were being sold in the United States at a price substantially lower than the price at which those products were sold in the Korean market.

The problem faced by the managers of Korean firm number one related to the fact that a competitor Korean firm had approximately matched their sales volume in the United States. If the competitor were to exceed the first company's total sales volume, then that would taint its image as "market leader." This would likely have had substantial negative effects in the domestic market.

The only channel through which one could respond to the challenge of its competitor quickly was to sell additional output to U.S. discount firms. Company two also was distributing in the U.S. through discount houses. Because of the imperatives of the Korean home market, firm one felt that it had to continue to offer concession-priced T.V. sets in the United States. It was imperative for them to remain the market leader. Their position in the United States had substantial payoffs in higher prices in their home market.

These firms are engaged in a global game with the U.S. marketplace as the one through which they gain reputation, economies of scale and low costs for their total production, and perhaps eventually, quality improvements through competition with others in the United States.

A key fact in this analysis is that these firms make very substantial profits in their home markets. This is irrespective of the level of profitability in the U.S. market. U.S. firms that are unable to participate in the Korean home market (or in the Japanese home market) for TV sets, do find themselves at a disadvantage. They lack an alternative through which to achieve profitability.

The television market has been one in which dumping has been consistently proven in accord with U.S. trade legislation. In the 1970s the main problems related to dumping by Japanese companies. We have just seen that in the 1980s Korean (and Taiwanese) companies were following a similar pattern with similar result.

Japanese firms such as Hitachi are vertically integrated firms. They participate not just in the consumer electronics market, but also in the market for semiconductors, including DRAMs, as both captive and merchant producers; their product lines extend to computer systems, from micro, to mini, to mainframes, to supercomputers. The table on the next page, taken from the IEEE-USA report entitled "U.S. Supercomputer Vulnerability," dated August 8, 1988, shows three integrated Japanese firms plus various U.S. firms. The Japanese firms thus have

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the ability to withstand pressures in one segment of their multi-centered activities through profits they achieve in others. For them, profits from consumer electronics, whether from the home market or from the U.S. market, can be used to help them penetrate markets for higher technology products. The situation faced by U.S. manufacturers of dynamic random access memories for the merchant market (circled item on the table below) over the past several years is quite different.

Market Segments Participated in by Selected U.S. and Japanese Manufacturers of Supercomputers and/or Semiconductors

	TI INTEL Motorola AMD ETC.							
	<u>CRAY</u>	<u>CDC/ETA</u>	<u>ETC.</u>	<u>AT&T</u>	<u>IBM</u>	<u>NEC</u>	<u>FUJITSU</u>	<u>HITACHI</u>
Super-computers	x	x			RE*	x	x	x
Main Frame Computers		x			x	x	x	x
Intermediate Computers					x	x	x	x
Mini Computers		x		x	x	x	x	x
Micro Computers					x	x	x	
Consumer Electronics						x	x	x
Semiconductors								
- Merchant			(x)			x	x	x
- Captive				x	x	x	x	x

* Re-entering.

The DRAM Semiconductor Problem

For a two-year period in the mid-to-late 1980s there was a huge over-supply of DRAMs. This over-supply resulted from heavy investment by the Japanese, well in excess of their domestic needs, combined with output by the Japanese factories at their planned capacity.

In the Japanese system the production manager is evaluated on his ability to produce high-quality products at low costs. This is generally best achieved by producing at the full capacity of operation of a given plant. This is what Japanese production managers do. The question of what happens to the output once it has been produced, is a "marketing problem."

The U.S. market has been the market of last resort for Japanese as for other firms. That is, excess output has generally been shipped to the United States. In this case the result was the extended period of chaotic pricing in DRAMs, with prices falling well below the cost of manufacturing.

U.S. merchant semiconductor firms are not vertically integrated. When the prices of their largest volume product, DRAMs, became depressed substantially below cost, these U.S. firms had no source of revenues other than semiconductors. They were forced to retreat from the market. They experienced the frequently-cited figure of 2 billion dollars in losses. The Japanese firms experienced the also frequently-cited figure of 4 billion dollars in losses. Nonetheless, the Japanese firms remained in the market for DRAMs. The 4 billion dollars of losses can be looked upon by the Japanese as an "investment" that has established their dominance over another market area. For the U.S. firms, 2 billion dollars in losses have remained losses.

The U.S. government exerted its efforts to convince the Japanese to cease "dumping" DRAMs into the U.S. market (and into third-nation markets). These efforts achieved success approximately at the point that U.S. firms exited from the market--and by chance, the point when worldwide demand for DRAMs began to pick up. The result was a sudden worldwide shortage of DRAMs. In response to the shortage, prices skyrocketed.

There has been some controversy over the "real" cause of the shortage of DRAMs in 1987-88 and even up to the present. Some people point to naturally-occurring problems of change-over from one generation of DRAMs to the next--that from the 256K-generation to the 1-megabit-generation--as the explanation for the shortage that followed so closely on the heels of the exit of so many U.S. firms.

However, students of the subject, including Dr. Kenneth Flamm of the Brookings Institution, who have compared the actual output of Japanese firms with the "forecast" made by MITI (The Ministry of International Trade and Industry in Japan) several months prior to that actual output, say (and MITI denies) that MITI ordained its level. In any case, there is an uncanny congruence between the MITI forecasts and the level of actual output. (Though in more recent periods, there has been some deviation from the forecast in a positive direction.)

After the U.S. firms had left the business, the net effect of the shortage was substantial windfall profits to the Japanese firms that continue to offer DRAMs. Two U.S. firms do continue to manufacture DRAMs, Texas Instruments and Micron Systems of Idaho. Nonetheless, Japanese output approximates 90% of world output of merchant-market semiconductors at this time.

What can we learn from this series of events? The most significant factor to note is that when the U.S. does not have domestic capacity in the hands of U.S.-owned firms, the U.S. is vulnerable to market swings such as those just discussed--irrespective of the cause of those market swings. This history suggests that the U.S. must have its own capacity in the hands of U.S.-owned firms.

This brief history also suggests the answer to the question, what difference does it make if the U.S. manufactures its own products or buys them from abroad? When you are dependent on others for products that are vital to your industry, you have lost control of your industry.

The recent very high price of DRAMs to U.S. firms manufacturing computer systems has had a substantially negative effect on the competitiveness of the computer systems of those firms. Note that as integrated firms, the Japanese manufacturers that sell DRAMs at high prices in the U.S., due to the current shortage, are also producing those products for internal use in their computer systems. Thus they have the ability to price their computer systems at a significantly lower price, should they choose to do so.

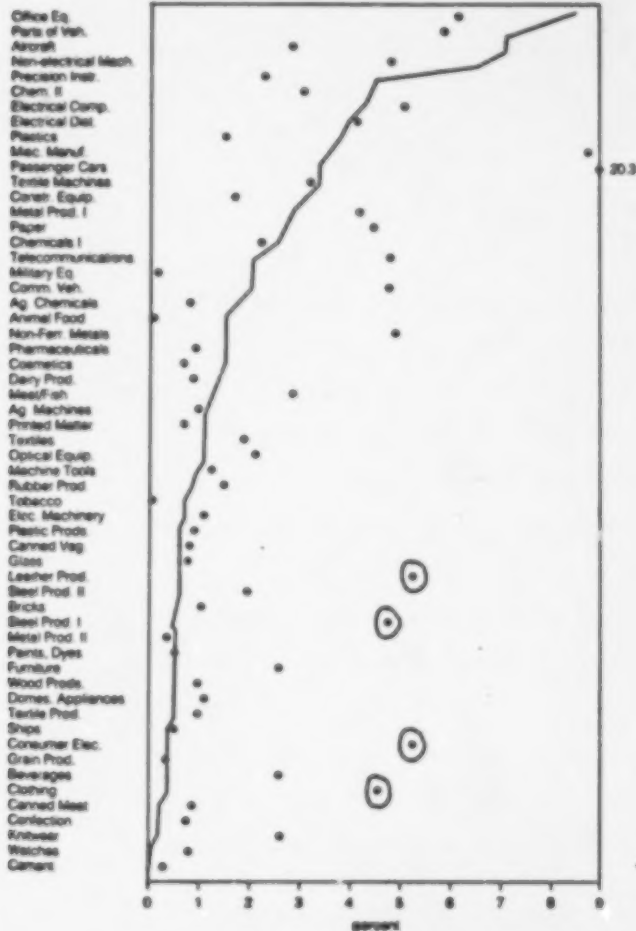
The Japanese Economy is Really "Different"

There has been much anecdotal evidence suggesting that doing business in Japan is quite different from doing business anywhere else in the world. These anecdotes apply to industry after industry, time period after time period, with conditions that are substantially different from one time period to the next, and from one industry to the next. The recent book by Clyde Prestowitz titled, Trading Places, compiles example after example.

Many economists have tended to dismiss this evidence as unconvincing, self-serving or worse. More recently, however, increasingly rigorous economic studies have been made of the phenomenon of interrelations between the Japanese economy and the economies of other industrialized nations. Evidence of both kinds was recently pulled together in the document, "Analysis of the U.S. Japan Problem: the Report of the Advisory Committee for Trade Policy and Negotiation," presented to the U.S. trade representative, Carla Hills, in February of 1989. Three graphs from this document, especially in the context of the vast anecdotal evidence that is presented in the document and elsewhere, make the point.

There is a pattern of trade for most industrialized societies. This pattern is evidenced by that of the United States shown in that document (Figure 5.2 from page 60), which is reproduced on the next page.

MANUFACTURED EXPORTS AND IMPORTS AS A PERCENTAGE OF TOTAL EXPORTS, 1985:
UNITED STATES



Source: "U.S. Competitiveness in the World Economy: An Update" by Bruce Scott, a paper presented at the Workshop on Competitiveness, Harvard Business School, July 12-18, 1987. Copyright © 1987 by the President and Fellows of Harvard College. Reprinted by permission of the Harvard Business School: JAPAN IN THE WORLD ECONOMY, Balassa and Noland, Institute For International Economics, Figure 3.3. Note: imports = •; exports = ____.

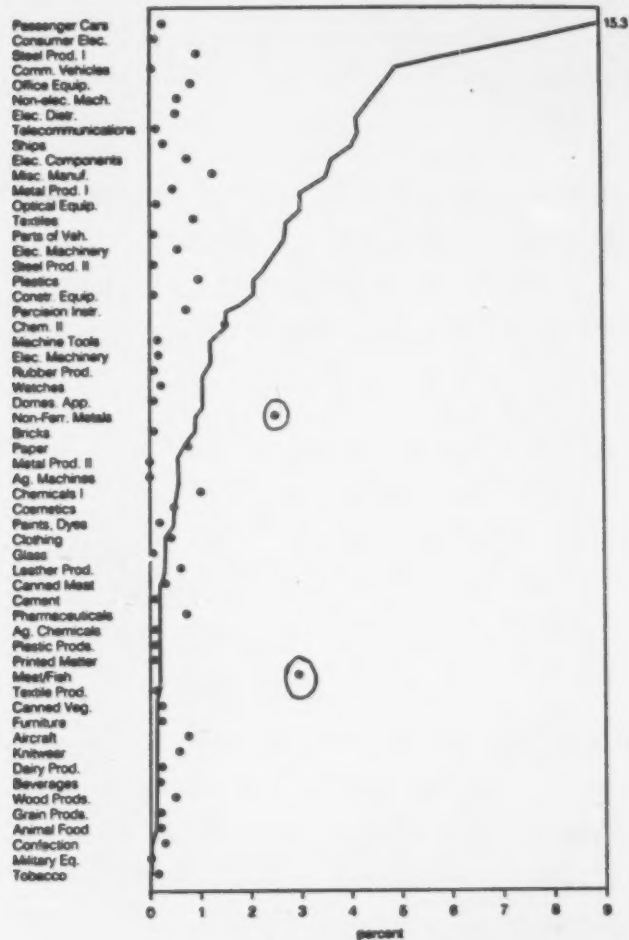
-14-

It is the pattern, not the details, that is important about this document. This diagram shows exports (as a solid line), in various industry manufacturing segments as a percentage of total exports for the United States in 1985, a typical year. It also shows imports in those same sectors (as a series of dots), as a percentage of the same base; that is, also as a percentage of total U.S. exports.

One can see that the pattern of dots tends to follow the pattern of the solid line. The solid line connects the export level of each of the successive industry segments from low-export to high-export segments. The highest export segment for the U.S. is "office equipment." The four circled items represent unusual import levels. These are "clothing," "consumer electronics," "steel products 1," and "leather products." These are obviously product areas where the U.S. must import since it has very little domestic capacity remaining in these items. In any case, the pattern is one which shows that with increasing levels of export in manufactured goods, a typical country will have increasing levels of imports in those same manufactured goods. This is because the domestic economy begins to specialize in particular elements of the high-export sector, while importing other elements from abroad. In the study which underlines the document, its authors prepared similar figures for Germany and several other highly industrialized countries. Their patterns even more closely approximated the stated relationship than does that of the United States.

Now let us look at Figure 5.1, reproduced from page 59 of that report and included as the next page. This shows the same relationships for manufactured exports and imports for Japan in 1985. With the exception of the two circled dots, (the first being for imports of "meat and fish" and the second "non-ferrous metals" i.e., aluminum--essentially congealed electricity) the Japanese pattern is strikingly different. Irrespective of the level of export, Japan's manufacturing industries import very little. This pattern applies to no industrial country other than Japan.

MANUFACTURED EXPORTS AND IMPORTS AS A PERCENTAGE OF TOTAL EXPORTS, 1985: JAPAN



Source: "U.S. Competitiveness in the World Economy: An Update" by Bruce Scott, a paper presented at the Workshop on Competitiveness, Harvard Business School, July 12-18, 1987. Copyright © 1987 by the President and Fellows of Harvard College. Reprinted by permission of the Harvard Business School: JAPAN IN THE WORLD ECONOMY, Balassa and Noland, Institute For International Economics, Figure 3.4. Note: imports = *; exports = ____.

The Japanese pattern is especially important for the electronics industry of the United States. The Japanese market is now the largest market for semiconductors in the world. It is a market in which the Japanese produce huge quantities for export, as we have just seen.

Now let us turn to the third diagram, Figure 6. 1, reproduced from page 100 of that report, and included here as the next page. This diagram shows U.S. semiconductor producers' market share in Japan. At the bottom of the diagram, is listed a whole series of liberalizations, market openings and so fourth, trumpeted by Japanese governmental agencies as demonstrations that the Japanese market is "open."

Again it is the pattern that is important. The graph shows a constant pattern, a pattern that does not change over time. The U.S. share remains virtually constant at approximately 10% of the Japanese market. This pattern is consistent with that in the earlier figure, Figure 5.1. Irrespective of their levels of exports in the manufacturing sectors, Japan, unlike other countries, does not import.

Despite all the negotiations which have taken place in the semiconductor industry, the Japanese market has remained essentially closed to American semiconductor firms. The opposite is obviously the case for the U.S. market. The U.S. market is open to semiconductor (and other electronics) manufacturers anywhere in the world.

With the Japanese market essentially closed and the U.S. market essentially open, U.S. firms are at a substantial disadvantage. Japanese firms are able to make profits in their domestic markets, and to price at marginal cost--or above as the situation permits--in the U.S. market. U.S. firms being essentially

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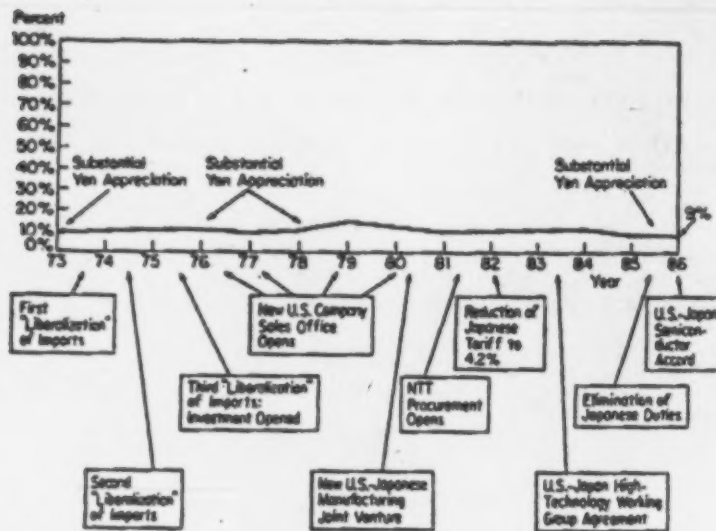


FIGURE 2.8
U.S. Share of Japanese Semiconductor Market

Source: Semiconductor Industry Association as reproduced in Trading Places: How We Allowed Japan to Take the Lead, by Clyde Prestowitz.

limited to these domestic markets, are dependent on these markets for their total performance. When the U.S. domestic market price is depressed--as was the case with the heavy over-supply of DRAMs in the 1985-86 time frame--U.S. firms, especially those that are "stand-alone" companies, can be quickly driven from the fields.

The U.S. semiconductor industry is populated with companies that have grown up from entrepreneurial start-ups. Most of the firms that serve the merchant semiconductor market are stand-alone companies. The table repeated on the next page, reproduced from the IEEE-USA report entitled "U.S. Supercomputer Vulnerability," shows the pattern of U.S. as compared to Japanese electronics firms. As noted earlier, the Japanese firms on the far right of the table are vertically integrated firms participating in multiple market segments. Most importantly for this discussion, they participate in consumer electronics, in the production of semiconductors for the merchant market, in the production of

Semiconductors for their own internal use both in consumer products and in the more advanced products, in the computer industry, and in supercomputers.

Market Segments Participated in by Selected U.S. and Japanese Manufacturers of Supercomputers and/or Semiconductors

	CRAY	CDC/ETA	TI INTEL Motorola AND ETC.	AT&T	IBM	NEC	FUJITSU	HITACHI
Super-computers	(X)	(X)			RE*	x	x	x
Main Frame Computers		(X)			x	x	x	x
Intermediate Computers					x	x	x	x
Mini Computers		(X)		x	x	x	x	x
Micro Computers					x	x	x	
Consumer Electronics						x	x	x
Semiconductors								
- Merchant			x			x	x	x
- Captive				x	x	x	x	x

* Re-entering.

The objective of the table in the IEEE report was to demonstrate the vulnerability of the U.S. supercomputer firms. They are much less integrated than are their Japanese competitors. (Note new items circled on the table.) Cray, the largest supercomputer manufacturer in the world, is effectively a stand-alone company.

Nations such as Japan can and do follow a pattern of using success in dominating a given area of electronics technology to provide leverage for extending the position into related areas. This is a pattern which we have seen over and over

in the U.S. economy. A protected home base for Japanese firms makes it extremely difficult for U.S. firms to compete against strategies of this kind.

Conclusions

Consumer electronics has proven to be a stepping stone into higher technology markets for those foreign firms that have chosen to focus on these businesses. The U.S. market is the main market outside of their home market upon which foreign electronics companies can focus. With their protected home markets, they are not dependent for their ultimate success on the cash flow from the consumer electronics or other businesses in the United States.

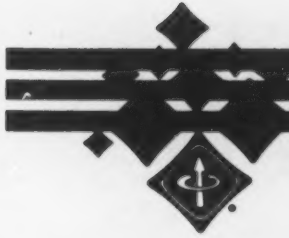
The experience of GE and RCA is of extreme importance in interpreting the real significance of the pattern of competition in electronics in the U.S. marketplace. U.S. firms have made their share of mistakes over the history of these markets. However, the RCA situation suggests that even when it can be the low cost producer, the U.S. firm may not be economically successful in the U.S. home market.

The situation in DRAMs fits the classic textbook pattern of anti-competitive behavior: actions that result in driving the competitor from the market place, followed by increased prices to recoup whatever losses were incurred in driving the competitor from the market place. Whether this pattern was conscious, inadvertent, or influenced by less-than-optimal U.S. policies, is beside the point. The pattern has taken place. U.S. computer manufacturers have discovered to their dismay the degree of their vulnerability to shortages of supplies from overseas suppliers, whatever the cause of those shortages.

It is in the interest of producers and consumers of U.S. electronics products alike to have the power to respond to such emergencies through U.S.-owned and controlled firms. It is in the national interest that this be brought about.

Perhaps the best way to complete this testimony is to restate the substance of the conclusions of the workshop referred to earlier:

- The survival of the U.S. industrial base in vital electronics sectors is at stake.
- To address the problem, we endorse industry-led consortia with government cooperation and support
- As a vehicle for addressing the crisis, dual-use technologies that meet both civilian and military needs should be developed in participation with both the Department of Defense (through the Defense Advanced Research Projects Agency [DARPA]) and the Department of Commerce (through the National Institute of Standards and Technology [NIST]). We applaud DARPA for supplying seed money for high resolution systems. Their initiative is of historic significance in recognizing that future low-cost military technology is intimately related to the health of U.S. design and full-scale manufacturing capability in consumer electronics, and that the initiative must be a market-driven, not a technology-driven enterprise.
- We recommend high-resolution systems (HRS) technology and world-class manufacturing as key areas for action. Displays and DRAMs are the most critical elements of this process.
- Industry-led consortia in threatened market segments must operate in an environment which is economically attractive. The government should facilitate this objective through the following actions:
 - a. Adopting measures for the provision of government financial support for U.S. industry-led consortia;
 - b. Recognizing the importance of an hospitable antitrust environment to the attraction of private U.S. capital;
 - c. Equalizing capital costs for U.S. participants in these global markets.
- These consortia must be dedicated to improving the competitiveness of U.S. firms and must contribute to the revitalization of the U.S. electronics industries. Consistent with these objectives, the consortia should be open to participants on a reciprocal basis.
- The IEEE-USA proposes to amplify and refine these concepts through a continuation of these workshops and debates. The objective is to help build the will, consensus, and resources necessary to meet the crisis.



ENTITY POSITION STATEMENT

A NATIONAL INITIATIVE FOR THE ELECTRONICS INDUSTRIES

1111 19th STREET, N.W. WASHINGTON, DC 20036-3690
(202) 785-0017

- *The U.S. must immediately re-establish significant technological capability and domestic manufacturing of world-class products by U.S.-owned firms based on electronic and related technologies that serve both civilian and military purposes.*
- *The situation is critical. A proactive stance by the Federal Government is required if these goals are to be achieved.*
- *A cooperative organization structured to function in the private sector, but with Government support, is an appropriate initial vehicle for implementing these goals in this country.*
- *The organization and its Government support must be in place this year.*
- *In the longer term U.S.-owned domestic manufacturers must be able to perform profitably in global markets over a broad technology base under conditions of true economic competition.*
- *This IEEE Council can assist in catalyzing the achievement of these goals by convening working sessions in the immediate future and providing appropriate support throughout the process of implementation.*

TECHNOLOGY ACTIVITIES COUNCIL

JANUARY 25, 1989

Approving Entity

Date

Today progress in electronic process technologies, cost efficiencies, and product quality are determined more by the demands from large scale consumer markets such as those for television, computers, and automotive electronics, than they are from military and space requirements. Linkages and spill-over effects are now becoming more prominent from the consumer sectors into the military, than they are in the reverse direction. The ability to design and manufacture sophisticated electronic and electromechanical systems is increasingly vital to a broad range of military and civilian products important to U.S. national security and to the future U.S. standard of living. Often technologies and components that are essential for civilian applications are identical to those vital for military weapons systems. Such "dual-use" items are also key elements in the evolving U.S. communications infrastructure upon which our economy and democracy depend.

The global consumer electronics market is now principally supplied from the Pacific Rim and to a lesser extent from Europe. The almost total elimination of U.S.-owned firms from domestic production of many dual-use products--and thus the loss of their design and manufacturing capability--represents a great danger to this country's military and economic security in areas such as computers, telecommunications, automation and modern weaponry. The necessity to purchase these products from foreign suppliers is contributing increasingly to the U.S. balance of payments deficit. As a nation we can no longer ignore these linkage and spill-over effects from consumer electronics to military and other national security areas.

Other countries have faced and overcome similar problems: there are lessons taught by their successes and failures that we must understand and incorporate into the process as the U.S. undertakes to reverse the current trends. The first lesson is that without the active cooperation and support of the domestic government, it is virtually impossible for a nation's industry to develop and maintain domestic capability in the face of well established, entrenched and aggressive competitors. U.S. Federal Government support, therefore, is essential as U.S.-owned firms become re-established and evolve to the level of global competitiveness.

An additional early conclusion from prior experience is that, given the U.S. economic system, a cooperative organization structured to function in the private sector is likely to prove to be the best vehicle for implementing initial development efforts. The actions of interested Federal Government agencies in support of such an initiative must be orchestrated and coordinated, and must include regulatory and trade actions, loan guarantees to help move capital costs toward competitive levels, and anti-trust clarifications to permit pilot manufacturing to prove design concepts. In addition, they must include cooperative projects among industrial research laboratories, universities, and U.S. Government laboratories. Progress toward the goals of the initiative must be continually evaluated and adjusted when and as necessary.

Consumer electronics, which include many of the most important and threatened dual-use technologies, are at a crossroad with further implications for the balance of trade. New sophisticated products—extended definition television (EDTV) and high definition television (HDTV)—at both the producers' and the consumers' levels are immediately on the horizon. Other nations are well ahead of the U.S. and are moving aggressively in their planning and development for these products. The Japanese are expected to make their first satellite test broadcasts with these products this year. The Europeans are also very active. Planning by U.S. industry is at an early stage.

Only if the U.S. establishes an independent presence now, will there be hope for the long-term recovery of this industry at a reasonable cost. Indicative of the depth of the problems this country faces in achieving this goal is the fact that the sole surviving U.S. television manufacturing firm is reported to be under serious pressure to sell this sector of its business. There is no likely U.S. buyer. The absence of strong U.S. voices with a major interest in the decisions even now being taken by the Federal Communications Commission and State Department—decisions that will determine the future of the U.S. market for decades to come—is likely to mean that foreign voices will determine their outcome.

The key goal of these initiatives for U.S.-owned domestic manufacturers is that they must be able to perform profitably with world-class products in global markets over a broad technology base under conditions of true economic competition. The implications of each step in the process of re-establishing and maintaining U.S. capability must be assessed against this longer term objective.

The IEEE is a professional society whose purpose is to promote and disseminate knowledge about the electrical and electronics fields, both in technology and technology policy areas. In the immediate future the IEEE-USA Technology Activities Council will sponsor workshops to bring its broad expertise and that of others to bear on these issues to help the nation generate an effective and timely action plan.

*Technology Activities Council
January 25, 1989*



UNITED STATES ACTIVITIES

Promoting Career and Technology Policy Interests of Electrical, Electronics & Computer Engineers

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STATEMENT OF
ALAN K. McADAMS
ON BEHALF OF THE
TECHNOLOGY ACTIVITIES COUNCIL
OF THE
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/
UNITED STATES ACTIVITIES
ON

ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE

BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

MARCH 22, 1989

IEEE-USA, 1111 - 19th Street, N.W. Suite 608, Washington, DC 20036-3690

The Institute of Electrical and Electronics Engineers, Inc.

STATEMENT OF
ALAN K. McADAMS
on behalf of the
TECHNOLOGY ACTIVITIES COUNCIL
of the
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/
UNITED STATES ACTIVITIES
on
ADVANCED TELEVISION SYSTEMS - REGAINING THE COMPETITIVE EDGE
before the
Committee on Science, Space, and Technology
United States House of Representatives
March 22, 1989

EXECUTIVE SUMMARY

1. The U.S. electronics technology base is in a situation of crisis with respect to both commercial and defense applications. To meet the crisis, the Technology Activities Council of the United States Activities Board of the Institute of Electrical and Electronics Engineers (IEEE) proposes a National Initiative to Revitalize the U.S. Electronics Industries.
2. The advent of high-definition television (HDTV), in all its ramifications, provides both an opportunity and a challenge to recover this country's posture in electronics.
3. Successful recovery, however, is threatened by a basic bias in the structure of the world electronics markets. In particular, closed domestic markets in Asia allow manufacturers there to recover full fixed costs at home and to price at low marginal costs in the United States. (Examples are television sets and dynamic random access memory circuits, or DRAMs.) Also, some Asian manufacturers have the advantage of extensive vertical integration, which lends strength to their enterprises. (Examples are supercomputer manufacturers.)
4. The United States cannot expect other countries to change an approach to their economy that has proven to be so successful for them. Therefore, the United States must deal with factors that it can control. For these reasons, a recent workshop conducted by the IEEE-USA Technology Activities Council recommended the following steps toward revitalizing the U.S. electronics industry base:
 - ° Creation of three industry-led consortia: on HDTV, on DRAMs, and on high-resolution systems (HRS).
 - ° An antitrust environment hospitable to the attraction of private U.S. capital.
 - ° Equalizing capital costs for U.S. participants in these global markets.
 - ° Temporarily countering the bias in the structure of the world electronics markets until U.S.-owned firms achieve world-class quality and costs for their products.

STATEMENT OF
ALAN K. McADAMS
on behalf of the
TECHNOLOGY ACTIVITIES COUNCIL
of the
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS/
UNITED STATES ACTIVITIES
on
ADVANCED TELEVISION SYSTEMS - REGARDING THE COMPETITIVE EDGE
before the
Committee on Science, Space, and Technology
United States House of Representatives
March 22, 1989

Thank you for inviting me to testify today as a representative of the Technology Activities Council, the principal technology policy council of the IEEE-USA. The IEEE is the world's largest engineering society, with over 300,000 members worldwide, 240,000 of whom live and work in the United States. It is a pleasure to be here, especially in such distinguished company.

My comments involve several related matters. Before reporting on the first, the recent IEEE-USA sponsored workshop in which several members of this panel participated, I would like to acquaint you with the Council's Position Statement of January 25, 1989, entitled,

"A NATIONAL INITIATIVE FOR
THE ELECTRONICS INDUSTRIES"

The key points of the statement can be paraphrased as follows:

- ° The current situation in the Nation's electronics industries is critical. A proactive stance by the Federal Government is required if the goal of re-establishing in the immediate future significant technological capability and domestic manufacturing of world-class products by U.S.-owned firms based on electronic and related technologies that serve both civilian and military purposes is to be achieved.
- ° A cooperative organization structured to function in the private sector, but with Government support, is an appropriate initial vehicle for implementing these goals in this country.
- ° The organization and its Government support must be in place this year.

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- * In the longer term U.S.-owned domestic manufacturers must be able to perform profitably in global markets over a broad technology base under conditions of true economic competition.

A portion of the discussion of this statement can also be paraphrased:

The global consumer electronics market is principally supplied from the Pacific Rim and to a lesser extent from Europe. The ability to design and manufacture low-cost, sophisticated electronic, and electromechanical systems is increasingly vital to a broad range of military and civilian products important to U.S. national security and to the future U.S. standard of living. Often technologies and components that are essential for civilian output are identical to items vital for military weapons systems. Such "dual-use" items are also key elements in the evolving U.S. communications infrastructure upon which our economy and democracy depend. Linkages and spill-over effects are now becoming more prominent from the consumer sectors into the military, than they are in the reverse direction.

The almost total elimination of U.S.-owned firms from domestic production of many dual-use products--and thus the loss of their design and manufacturing capability--represents a great danger to this country's military and economic security in areas including computers, telecommunications, automation and modern weaponry. The necessity to purchase these products from others is contributing an increasing portion of the U.S. balance of payments deficit. As a nation we can no longer ignore these linkage and spill-over effects from consumer electronics to military and other national security areas.

There is much to learn from the experience of other countries that have overcome problems similar to those we now face. The first lesson is that without the aid of the domestic government, it is virtually impossible for a nation's industry to develop domestic capability in the face of well established, entrenched, aggressive foreign competitors. U.S. Federal Government support, therefore, is essential in a period during which as U.S.-owned firms are attempting to become re-established and to evolve to the level of global competitiveness.

Now to the workshop organized by the IEEE-USA in response to the Position Statement. The workshop took place on February 13-14, 1989. The workshop reached a tentative consensus on several points. A summary of its conclusions taken from its news release is:

- * The survival of the U.S. industrial base in vital electronics sectors is at stake.
- * To address the problem, we endorse industry-led consortia with government cooperation and support.
- * As a vehicle for addressing the crisis, dual-use technologies that meet both civilian and military needs should be developed in participation with both the Department of Defense (through the

-3-

Defense Advanced Research Projects Agency [DARPA]) and the Department of Commerce (through the National Institute for Standards and Technology [NIST]). We applaud DARPA for supplying seed money for high resolution systems. Their initiative is of historic significance in recognizing that future low-cost military technology is intimately related to the health of U.S. design and full-scale manufacturing capability in consumer electronics, and that the initiative must be a market-driven, not technology-driven enterprise.

° We recommend high-resolution systems (HRS) technology and world class manufacturing as key areas for action. Displays and DRAMs are the most critical elements of this process.

° Industry-led consortia in threatened market segments must operate in an environment which is economically attractive. The government should facilitate this objective through the following actions:

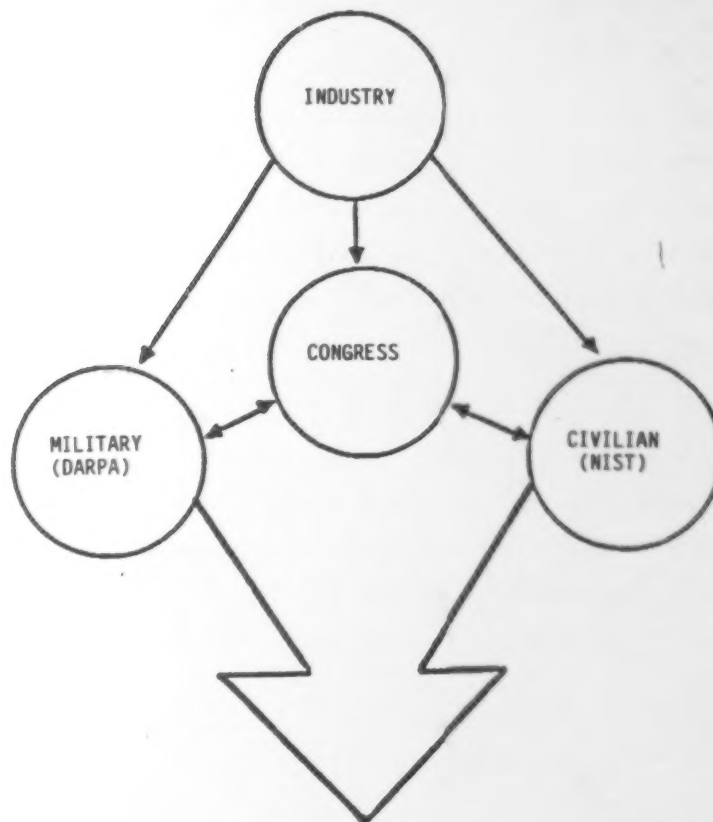
- a) Adopting measures for the provision of government financial support for U.S. industry-led consortia;
- b) Recognizing the importance of an hospitable antitrust environment to the attraction of private U.S. capital;
- c) Equalizing capital costs for U.S. participants in these global markets.

° These consortia must be dedicated to improving the competitiveness of U.S. firms and contribute to the revitalization of the U.S. electronics industries. Consistent with these objectives, the consortia should be open to participants on a reciprocal basis.

° The IEEE-USA Council proposes to amplify and refine these concepts through continuation of these workshops and debates. The objective is to help build the will, consensus, and resources necessary to meet the crisis.

A graphical presentation of these conclusions is presented on page four. This workshop sponsored by the IEEE-USA that I had the privilege of co-chairing with Professor David Staelin of MIT on the 13th and 14th of February, 1989, had the active participation of some 60 persons knowledgeable about various aspects of the electronics industries. As the summary shows, the workshop achieved consensus on a number of important points.

INDUSTRY LED CONSORTIA TO REVITALIZE THE
U.S. ELECTRONICS INDUSTRIES



CONSORTIUM

1. HDTV (High Definition Television)
2. DRAMs (Dynamic Random Access Memories)
3. HRS (High Resolution Systems)

INDUSTRY LEADER

AEA (American Electronics Association)
SIA (Semiconductor Industry Association)
??? (Not yet identified)

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All agreed on the seriousness of the situation the United States currently faces in relation to its electronics technology base. To meet this critical situation the workshop strongly endorsed a "National Initiative to Revitalize the U.S. Electronics Technologies." Specifically, it recommended the three industry-led consortia detailed above.

It should be clear that consortia 2 and 3, those for high resolution systems and DRAMs, involve components appropriate for inclusion in high definition televisions, the object of consortium number 1. Successful completion of the former two initiatives would result in products manufactured by U.S.-owned firms that could be incorporated into such systems. Since these products also have multiple uses, both civilian and military, they are worthy of their own initiatives.

This concludes my prepared statement for today, however I request the opportunity to submit an extended version for the hearing record. This extended version will support the points I have used concerning the structure of world electronics markets. Thank you again for the opportunity to appear before you today. I will be happy to answer any questions you may have.

COMMENTS OF THE
COMMITTEE ON COMMUNICATIONS AND INFORMATION POLICY
AND THE
COMMITTEE ON U.S. COMPETITIVENESS
OF THE
UNITED STATES ACTIVITIES BOARD
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

INTRODUCTION

1. The Committee on Communications and Information Policy (CCIP) and the Committee on U.S. Competitiveness (CUSC), both of the United States Activities Board of the Institute of Electrical and Electronics Engineers, Inc., are actively studying several of the issues pertaining to the introduction of High Definition Television (HDTV) in the United States.
2. A number of interrelated issues that must be addressed include: technology developments, benefits to the consumer, benefits to U.S. industry, the need for standardization, compatibility with existing receivers, and spectrum utilization. These are addressed briefly in the following pages.
3. The Interim Report of the Federal Communications Commission (FCC) Advisory Committee on Advanced Television Service, June 16, 1988, hereafter referred to as the FCC/AC report, describes progress on the FCC's efforts to come to grips with HDTV issues. More recently, the FCC issued a Tentative Decision and Further Notice of Inquiry, dated September 1, 1988, in which it took the position that a terrestrial broadcast standard that is compatible with the present National Television System Committee (NTSC) standard would be forthcoming and that the availability of spectrum for broadcast HDTV would have to come from within the existing VHF and UHF television spectrum allocations.
4. We commend the FCC and its Advisory Committee and recommend that the United States continue to play a proactive role in international decision-making for HDTV lest the United States find itself subjected to decisions made elsewhere in the world, which could work to its disadvantage. Currently, new video standards are being set by the Japanese-dominated video cassette recorder (VCR) industry. The United States can best influence this process with a timely stance by the FCC and American industry.
5. The FCC should continue to foster a proactive, participatory effort to lead to clear decisions and to strive for a timetable that will allow a timely, but thoroughly considered, introduction of HDTV in the United States.

TECHNOLOGY DEVELOPMENTS

6. It is generally acknowledged that the technology now exists to permit TV production and delivery for high quality video comparable to 35mm film and digital audio comparable to that offered by compact discs. The NTSC standard for TV has existed for nearly 50 years and has been significantly modified only once (to incorporate color). Since this standard was developed, major technology advances have occurred including solid state integrated circuitry, digital signal processing circuitry and software, video recording, satellites, and fiber optic cables.

7. The NTSC standard evolved with the premise of delivery via terrestrial VHF/UHF broadcast. In recent years, cable and satellite media have had a significant impact on the transmission of programs while VCRs and video disc technology have offered new means of delivery of program material to the consumer. Direct Broadcast Satellites (DBS) are already a reality in Japan and will soon be in Europe and it is expected that they will emerge in the United States in the future. Fiber optic cables are increasingly being installed in the distribution networks of local telecommunications companies. These developments point to an increasing diversity of choices and options in TV production, distribution, and delivery, which were not anticipated in the now huge infrastructure surrounding NTSC.

8. It is important to recognize that any consideration of HDTV must take a total systems approach to TV production, distribution, and delivery and not be limited merely to issues surrounding the TV receiver and spectrum allocation. Also, it is important to take a long-term view of technology, since once adopted, any new system can be expected to be in operation well into the next century.

BENEFITS OF HDTV TO THE CONSUMER

9. Potential benefits go beyond the technical aspects of better resolution, wider aspect ratio, and better sound. For example, the better resolution can not only improve existing pictures but can offer the program creator opportunities to display images that are not feasible on television today. Some argue that once consumers see the quality of HDTV they will demand it. Others point out that consumer demand has yet to be demonstrated and, in any case, it will depend on the cost. If implementation of HDTV resulted in an increase in utility as perceived by the consumer, there would almost certainly be a demand for it. However, if the consumer is required to discard existing equipment in favor of sets costing much more, it is not yet clear to what extent and how rapidly a migration to the new system would occur. To the extent that consumer desire for maximum picture quality is demonstrated, a strong case can be made that if a new system is adopted, it should strive for the best picture, consistent with technical and economic factors, thus suggesting that "compromise" systems offering only moderate improvements will not be in the long-term interests of the consumer or the TV industry, particularly if very high-quality TV is offered in other parts of the world.

10. Additional controlled and quantifiable tests are urgently required in order to put the perceived benefits of HDTV in perspective. These test results are an essential element in establishing the standard for HDTV.

11. The FCC/AC report acknowledges this. Specifically, Planning Subcommittee/Working Party 6 (PS/WP-6) of that committee has proposed a test methodology for performing subjective evaluations of candidate systems.

BENEFITS TO U.S. INDUSTRY

12. It has been suggested that HDTV may present a unique opportunity for U.S. industry to reenter the TV manufacturing arena. Some contend that the United States is already heavily involved in a significant way. Comments to the FCC/AC report point out that more than 500,000 people in the United States are actively

involved in the manufacture, distribution, sales, and service activities, and at least twenty companies make TV sets in the United States, although all but one (Zenith) are foreign-owned and most of the components assembled in the United States come from offshore.

13. The key questions regarding HDTV's potential impact on U.S. competitiveness are:

- * Would a unique U.S. standard provide a competitive advantage to potential U.S. reentrants?
- * Would an early standard for HDTV transmission place U.S. industry in a more competitive position?

14. Examples in other countries, such as Brazil and France, suggest that unique standards based on excluding competition rather than on quality are counter-productive to the interests of the consumer and offer little benefit to industry. Proponents of a quick adoption of a single standard argue that it offers the best opportunity for U.S. industry to achieve a competitive position. Opponents argue that HDTV technology is rapidly and continually evolving and this progress could be strangled by a premature standard. Also arguing against hasty adoption is the fact that the candidate systems have not been fully evaluated from the viewpoint of transmission impairments. Comments to the FCC/AC report point out that in any case the "advantages" of early adoption vis-a-vis competitiveness are illusory--foreign manufacturers will quickly adapt to the technology and the underlying factors that make the United States non-competitive will not have been addressed.

15. The competitiveness of the U.S. television set manufacturing industry will not be materially aided by adopting a unique or an early U.S. standard. Therefore, U.S. competitiveness should not be a controlling factor in setting an HDTV standard, either in its makeup or timing of its adoption.

SINGLE SET OF STANDARDS

16. The objective is a single set of standards for terrestrial broadcast, display, and the interface between them. Each is discussed below.

17. The display standard is very important because it establishes the ultimate picture quality for the consumer. Therefore, its parameters should be defined to allow for the highest practical HDTV quality taking into account the tentative production standard and accommodating all the potential delivery media.

18. The interface standard should be consistent with the high-quality display and should also accommodate the various delivery media. For example, it could be based on individual signal components such as the Red-Green-Blue signals (RGB), broadband ISDN, etc.

19. The terrestrial broadcast standard should encompass transmission and receiver parameters which are consistent with the above interface and display standards.

20. The FCC Tentative Decision and Further Notice of Inquiry indicates that an NTSC-compatible standard will be forthcoming for terrestrial broadcast which will accommodate existing NTSC sets. This standard may utilize an additional 3MHz or 6MHz of bandwidth to provide improved quality.

21. This standard may not yield deliverable quality as high as can be provided by other media such as cable, satellites, fiber optics, and VCRs. Therefore, as indicated above, the standards for the HDTV display and interface should not be limited by the terrestrial broadcast parameters, but should be capable of delivering the highest available quality.

22. There is no urgency to set a standard for delivery by other media such as satellites and cable. The FCC appears unsure of its authority in this area and these media are expected to adapt rapidly when the display and interface standards are defined.

23. The FCC should, in a timely manner, produce a single set of standards for display, interface, and terrestrial broadcast. The display and interface standards should be capable of accommodating other media and be consistent with the highest deliverable HDTV quality.

COMPATIBILITY WITH EXISTING RECEIVERS

24. A fully compatible system allows reception of HDTV signals by an NTSC receiver without significant degradation in quality below present NTSC color transmission and an HDTV receiver would also be able to receive an NTSC signal without degrading it. The FCC Tentative Decision and Further Notice of Inquiry maintains compatibility with the NTSC systems and existing allocations. We support the tentative decision to make terrestrial broadcast HDTV compatible with NTSC systems provided that such action has no impact on the high-quality display and interface standards mentioned above, which would be utilized by the non-broadcasters.

SPECTRUM UTILIZATION

25. Optimum HDTV will undoubtedly require more than the 6MHz per channel used by NTSC. But the additional spectrum needed to expand existing TV broadcast channels in this way is also needed by an expanding private and public mobile radio service. This contributes to the difficulty of the adoption of terrestrial broadcast HDTV which requires additional spectrum allocations. It must be noted that while it is possible to provide TV delivery by non-broadcast means, and in fact nearly 50% of United States homes are serviced by cable or satellite, it is not possible to serve mobile radio by such means. Some compromise in the number or spacing of broadcast channels is likely to be required in urban areas to accommodate the higher bandwidth required by each channel.

26. The standard adopted for terrestrial broadcasting should not be constrained by the current 6MHz broadcast channel bandwidth. The conduct of further tests and simulations can yield meaningful data to assist in making an informed decision regarding spectrum issues. Therefore, such tests should be carried out before adoption of a standard. In order that decisions not be delayed, some urgency should be given to the spectrum allocation questions.

SUMMARY OF RECOMMENDATIONS

1. The FCC should continue to foster a proactive, participatory effort to lead to clear decisions and to strive for a timetable that will allow a timely, but thoroughly considered, introduction of HDTV in the United States.
2. It is important to recognize that any consideration of HDTV must take a total systems approach to TV production, distribution, and delivery and not be limited merely to issues surrounding the TV receiver and spectrum allocation. Also, it is important to take a long-term view of technology, since once adopted, any new system can be expected to be in operation well into the next century.
3. Additional controlled and quantifiable tests are urgently required in order to put the perceived benefits of HDTV in perspective. These test results are an essential element in establishing the standard for HDTV.
4. The competitiveness of the U.S. television set manufacturing industry will not be materially aided by adopting a unique or an early U.S. standard. Therefore, U.S. competitiveness should not be a controlling factor in setting an HDTV standard, either in its makeup or timing of its adoption.
5. The FCC should, in a timely manner, produce a single set of standards for display, interface, and terrestrial broadcast. The display and interface standards should be capable of accommodating other delivery media and be consistent with the highest deliverable HDTV quality.
6. The standard adopted for terrestrial broadcasting should not be constrained by the current 6MHz broadcast channel bandwidth. The conduct of further tests and simulations can yield meaningful data to assist in making an informed decision regarding spectrum issues. Therefore, such tests should be carried out before adoption of a standard. In order that decisions not be delayed, some urgency should be given to the spectrum allocation questions.

ABSTRACT

This workshop, which was broadly attended by about 55 participants from U.S. industry, academia, and government, was held in response to the IEEE-USA Technology Activities Council entity position paper of January 25, 1989, which concerned the urgent need for an immediate national response to significant deterioration in vital U.S. electronics sectors, with an emphasis on high-resolution systems. Working groups on Organizational and Effectiveness Issues, Technology and Manufacturing Capabilities, and Standards and Services met and then reported to plenary sessions where overall consensus was sought. This report summarizes the discussion and conclusions reached in these sessions concerning the creation of government/industry partnerships through formation of American Technology Corporations.

Rapporteurs

D. H. Staelin, H. James, L. W. McKnight, and S. C. Neil

Co-Chairmen

A. K. McAdams and D. H. Staelin

Workshop on Creation of
Government/Industry Partnerships
through the Formation of
American Technology Corporations
February 13-14, 1989
National Research Council
Washington, D.C.

sponsored by
The Institute of Electrical and Electronics Engineers
United States Activities - Technology Activities Council
(IEEE-USA)

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I. Highlights of Conclusions

The Workshop, which was broadly attended by about 55 participants from industry, academia, and government, reached consensus on several points:

- Survival of the U.S. industrial base in vital electronics sectors is at stake.
- Industry-led consortia with government cooperation and support are necessary to address the problem.
- Dual-use technologies meeting both civilian and military needs should be developed with participation by both the Department of Defense and Department of Commerce¹.
- High-resolution-systems technology and world class manufacturing are key areas for action. Displays and DRAMS are the most critical elements.
- The IEEE-USA entity position statement of January 25, 1989 was endorsed (see Appendix A); it further called for such consortia and associated government support to be established this year.

The Workshop applauded the DARPA¹ initiative in providing seed money for high-resolution systems, which is of historical significance in its recognition that 1) future low-cost military technology is ultimately related to the health of U.S. consumer electronic design and manufacture and 2) that such dual-use activities must also be market-driven. Establishment of competitive U.S. high-resolution systems technology and manufacturing for displays, DRAMs², and supporting technologies was particularly recommended.

These industry-led consortia must attract U.S. firms by providing an environment that is economically attractive and that reduces risks to the participants. The government should support these objectives through the following actions:

¹ For example, by the Defense Advanced Research Projects Agency (DARPA) and the National Institute of Standards and Technology (NIST; the former National Bureau of Standards), respectively.

² DRAMs are dynamic random access semiconductor memory devices that are central to current computers, future HDTVs, and other products.

- Providing financial support for U.S. industry-led consortia,
- Recognizing the importance of an hospitable antitrust environment to the attraction of private U.S. capital, and
- Equalizing capital costs and risks for U.S. participants relative to foreign competitors in these global markets.

These consortia must be dedicated to improving the competitiveness of U.S. manufacturing firms and contribute to the revitalization of the U.S. electronics industries. Consistent with these objectives such consortia should be open to participants on a reciprocal basis.

II. Issues Addressed in Plenary Sessions³

A. U.S. Situation Assessment

1) Technology

It was felt that the most critical issue is the integrity of the electronics "food chain" (see Figure 1), where this chain extends from critical materials (such as silicon and gallium arsenide) to components, subassemblies, and integrated systems, as well as to the associated research and development for both product and manufacturing processes and equipment. The greatest weakness today is in the lower levels of the food chain, particularly as they relate to low cost world-class manufacturing in volume. "Flexible manufacturing" and "design for manufacturing" were also cited as two key areas of relative weakness. These fundamental weaknesses in manufacturing impact not only consumer electronics but also the related fields of computers, telecommunications, and other industrial sectors dependent upon low cost sophisticated electronic elements.

There was agreement that it is not too late for the U.S. to reenter world consumer electronics markets, for we still retain residual research and development capabilities in this area -- the problem is one of scaling up competitively. Reentry should be centered on emerging technologies rather than those which are obsolescent. In such a reentry Zenith Electronics

³ Repetition of IEEE-USA position paper concepts (Appendix A) is omitted here.

Corporation and the SRI David Sarnoff Laboratories are important national assets because they comprise the largest surviving U.S. resources in this area.

TECHNOLOGY/MANUFACTURING LINKAGES

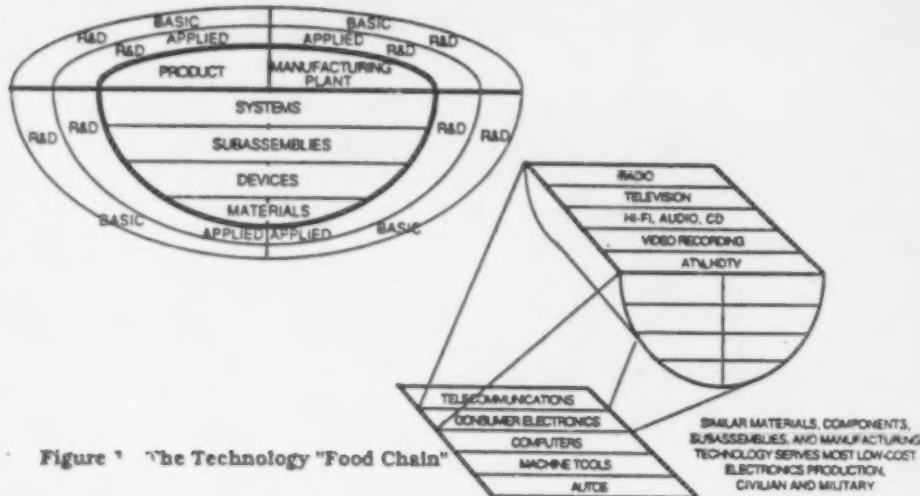


Figure 1 The Technology "Food Chain"

2) Economics

The single most important economic issue is industry's need for long term capital at rates comparable to the effective costs of capital for U.S. competitors. The estimated effective costs of such capital for Japanese firms was 3.5%, versus 11% (or more) for U.S. firms. It was felt that this sort of discrepancy, by itself, could systematically foreclose the future for such disadvantaged U.S. manufacturing firms, particularly those firms with the greatest need for such long term investments.

Other aspects of the U.S. macroeconomic environment were felt to be more unchangeable, and Lester Thurow's characterization seemed apt. His recently expressed view is that the U.S. is in a "growth tunnel" where the growth must be held in a narrow range of approximately 3-3.5% per annum. This growth rate is bounded from above by difficulties in attracting adequate capital at acceptable rates to grow more rapidly, and is bounded from below by our need to create a U.S. market for Latin American exports so that these countries can pay their debts; significant default on these debts could

conceivably precipitate a banking crisis. These constraints, plus the inertia of present government policies and the lack of a sense of crisis, make continuation of present macroeconomic policies the most likely outcome. The Workshop expressed concern that in this macroeconomic climate the U.S. will continue to lose not only its technological industrial base, but also its ability to recreate that base, unless significant steps are taken. Discussion of some of these steps was one of the purposes of this Workshop.

3) Competitiveness

There was widespread agreement that the present U.S. competitive position in low cost sophisticated electronics has seriously deteriorated, principally during the past decade. It was felt that we still retain, for the moment, an ability to turn this situation around. To do this, however, focus must be placed on corporate investment strategy and financial return. There is a serious need to lower investment risks for U.S. firms. Such concerns about investment strategy were said to be critical, for example, for the more than 25 firms now collaborating with the AEA in the definition of a consortium. The importance of participation by major U.S. corporations was cited, and the belief was expressed that with such participation there would be significant interest by smaller firms as well.

B. Japanese and European Development Strategies

Among the strategies found to be valuable overseas was the tendency to view the technology base as a chain (e.g., "food chain") running from semiconductors through semiconductor manufacturing and into computers and other product lines. Cardinal rules of industrial strategy are to build the food chain and never to break it. There was a perceived tendency to use the government as a technological innovator which underwrites major initiatives and then virtually transfers them to corporations which develop the applications. In doing this they preferred to leapfrog current technologies by focusing on the next generation. This approach was felt to characterize both the Europeans and the Japanese fairly well, with RACE, Eureka, and Pan-Europe (1992) being examples.

C. Standards

The role of standards is very important, and it was agreed that transition

to new television capabilities must start with today's television -- it will not go away soon. Nonetheless it was suggested that at some point the U.S. should establish a timetable for explicitly phasing out NTSC. Further it was felt that the FCC cannot limit non-broadcast media to the use of FCC broadcast standards, and therefore it is essential that a "friendly family" of standards be developed which permits economic interconnectivity. To have multiple non-compatible standards would be most unfortunate -- the issue is not so much the number of standards, but rather their compatibility.

D. DRAMs

It was recognized that the U.S. is effectively out of the merchant DRAM² business, largely because foreign competitors have been willing to continue to produce at plant capacity irrespective of the price their output commands. It was estimated that one significant DRAM plant would cost the U.S. two billion dollars (and satisfy a significant portion of the U.S. demand). Continued U.S. DRAM production was felt to be critical to the competitiveness of U.S. electronics firms whether or not this plant itself would make a profit because of the central role of DRAMs in determining product performance and cost. It was estimated that one-third of all DRAMs are currently used in consumer electronics (including home computers) and that this proportion could double over the next ten years. It was suggested that establishment of such world-class U.S. domestic capability was absolutely essential to preserve the independence and integrity of U.S. electronics manufacturers in an uncertain competitive world.

E. Congressional/Governmental Situation

There was widespread agreement on the need for federal government action this summer or fall, and that emergence of one or more strong national leaders from industry would be extremely important and useful. Present problems of the current administrative transition were felt to be significant in that the delays in launching new initiatives could hinder needed actions in this industrial area. Transitional problems include not only the necessary learning time for new political appointees to the administration, but also delays introduced by new assignments to congressional committees.

Approximately seven congressional committees and subcommittees are involved. One particularly active series of hearings is that being conducted by

Congressman Markey, who has already held several and apparently plans 3-4 more during the coming months. Additional members of Congress known to this group to be currently involved in these issues are Brown, Dingle, Hollings, Levine, Ritter, Roe, and Walgren.

F. Television and Related Future Businesses

Partly because foreign firms use the large U.S. market as a battleground for global market share, traditional television manufacturing for this U.S. market has generally been unprofitable for all participants, and thus has been a generally unattractive business for U.S. corporations. But it was felt that television sets alone are not the issue. What is actually at stake now in television is the future of the high resolution systems industry and of related industrial sectors in computers and telecommunications. The intersection of these "information" sectors will provide the basis for an entirely new and broad industry. One important first step for this U.S. industry, given the present competitive situation, would be formation of industrial consortia, initially with an R&D focus, but most likely extending to manufacturing at global scale.

G. Relationship Between Manufacturing and R&D

Recent studies of industrial competitiveness have emphasized the critical importance of "design for manufacturing" and the need to integrate much better the choice and development of manufacturing processes with the design of products. It is increasingly recognized that most manufacturing firms without such strong cross linkages between product design and manufacturing will have a significant competitive disadvantage in global markets. Thus it was felt that consortia must extend beyond research and development to include considerations of the manufacturing processes, pilot manufacturing, and scale-up issues. It was suggested that bringing a product to scale was significantly different from going only to pilot production. Some argued that it is important to keep one team the whole way through, from R&D to manufacturing at scale, and others felt that manufacturing engineers detailed to a joint R&D project would be eager to bring home the fruits of research.

H. Antitrust Issues

Antitrust is clearly an area of great interest, where the issues include not only the law itself, but also how the law is perceived and the debilitating precautions firms may take to reduce their perceived risks.

There are two concerns with antitrust law: a government suit that could result in an injunction to unscramble the activity, or a private suit that could result in treble damages. Three ways to guard against these are:

1) A legal opinion from an expert stating that the activity is framed in an acceptable fashion. This option offers reassurance but no real protection; such opinions are relied upon perhaps 95 percent of the time.

2) A business review or advisory opinion from the Department of Justice (DOJ). Most requested reviews are obtained in 3-6 months, and they offer protection from government suits, but not from civil suits, where they are nonetheless frequently persuasive.

3) A statute, which is the only means affording total protection, but it is very difficult to obtain and is usually not industry specific.

It was explained that the risks of joint activities were least when the collaborators represent a small fraction of the actual and potential competition in an industry and when they focus on research and the early stages of development. Even in the manufacturing stage, joint ventures which do not create or abuse market power may now be permitted, but the risk of treble-damage civil suits clearly is increased. Such perceived risks have largely precluded many manufacturing joint ventures, even in sectors where U.S. firms currently have little presence. It was generally felt that legislative clarification of this issue would therefore be very useful. Such legislation should specifically reduce or remove risks for firms collaborating in a market area otherwise overshadowed by strong foreign competitors. Some participants suggested less controversial arrangements such as joint ventures should therefore be explored in preference to consortia.

It was noted that there is precedent for finding that antitrust laws are not applicable to a state or federal government entity, and the Supreme Court has on numerous occasions explored the extent to which such immunity could be extended to private entities acting in partnership with government. Therefore the government may now have sanction to immunize a consortium or venture by participating in it⁴. Further, it would appear to be a small extension of this precedent through legislation to give the government sanction to immunize a consortium from antitrust challenge if 1) some

⁴ See, for example, *Parks, v. Brown* [317 U.S. 351, 352], or *Southern Motor Carriers rate conference v. U.S.* [471 U.S. 48 (1985)].

government support is provided to the consortium and 2) if the DOJ provides an opinion letter finding that the proposed venture is not anti-competitive. Specific legislation would be required for this extension of precedent, but it would not require the need for broad reexamination of U.S. antitrust law. It was felt that a broad reexamination would incur the risk of major delays.

I. Participation by Foreign Firms

There was consensus that the principal objective of these consortia must be establishment and maintenance of a broad world-class U.S. domestic technological and manufacturing capability by U.S.-owned electronics firms. Participation by foreign firms consistent with such objectives of a consortium might include sharing critical technology, conduct of important research and development in the United States, significant purchases of related U.S. high technology products (strengthening the "food chain"), etc. It was suggested that such participation should be defined not in terms of rules and regulations, but rather in terms of substance responsive to evolving situations. If participation by foreign firms was consistent with these objectives, then the criterion of reciprocity would be invoked. The key element of reciprocity would be that similar organizations in the home country of a foreign firm would be open to U.S. participants on terms that prove to be equal in practice to those of the U.S. consortium.

J. Relative Roles of Industry and Government

The consensus was that consortia should be industry-led and that government should provide an environment within which such industry initiatives could be successful. Such government steps should include 1) providing limited financial support, initially for selected research and development initiatives, but also possibly extending to support necessary to permit full-scale manufacturing, 2) equalizing long-term capital costs for U.S. participants relative to foreign competitors, and 3) providing a more hospitable antitrust environment. Helping to ensure reciprocal access to foreign markets and adherence to fair practices by competitors were also felt to be important. Furthermore, to the degree practical, competition among U.S. firms could be helpful, particularly in early R&D phases. One recommendation was to follow the example of the Bird Foundation, a joint U.S.-Israeli foundation that responds to proposals for jointly funding risky new technologies. DARPA and NIST were felt to be two appropriate vehicles for the government to use in addressing such technology issues. Figure 2 was presented as a schematic rendition of the proposed government/industry partnership.

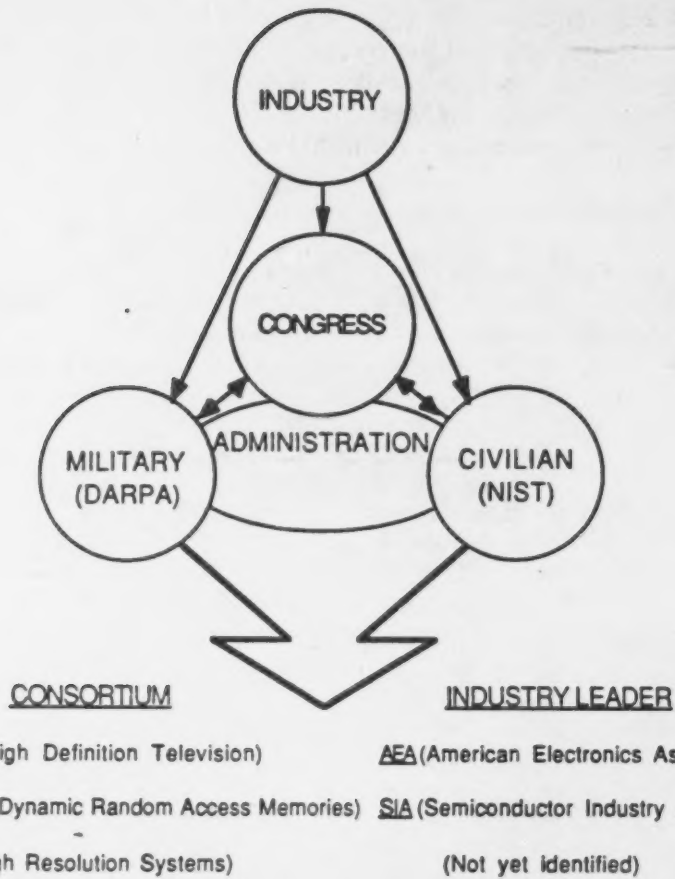


Figure 2. Industry-Led Consortia to Revitalize U.S. Electronics Industries (HDTV and HRS might be unified)

K. Implementation of Workshop Recommendations

Participants agreed that the Workshop had been very helpful in developing understanding and consensus on a number of important issues and that the essence of these discussions should be made available in a report. They also agreed that additional workshops on related critical issues could be very helpful.

III. Issues Addressed in Working Group A: Organizational and Effectiveness Issues

A Foreign Participation

The working group attached particular importance to the conduct by foreign firms of significant research and development activities within the United States, and it noted that Thomson and Phillips appeared to be particularly effective in this area. Opposition to a blanket prohibition of foreign participation in U.S. consortia was based on concerns for good business practice and for reciprocity, because U.S. firms operating abroad have the mirror-image problem. For example, just as IBM has made important technical contributions to European and East-Asian computer manufacturing firms, so could non-U.S. firms make similar contributions here. Such contributions have to be evaluated on a case-by-case basis.

Meaningful broad penetration of the Japanese high technology market by U.S. firms should be linked to the issue of consortium reciprocity. Linkage to issues such as dumping, intellectual property, etc. was also advocated. It was noted that although such access is presently very difficult in Japan, its market is not impenetrable.

In response to the question concerning how foreign firms with enormous technological advantages could be excluded from U.S. consortia (or if they should be), it was noted that the net contribution to the reestablishment of a self-sustaining U.S. technological base plus the key issue of reciprocity should be the key criteria for making such a determination. The question should be decided on an ad hoc basis reflecting all relevant circumstances.

B Local Research and Development and Intellectual Property

It was felt that conduct of, and some fair mechanism for sharing, significant research and development in the U.S. should be given considerable weight when discussing the contribution of a foreign firm to reestablishing the U.S. technology base, and that requirements in this area may even be desirable. Participation in a consortium could be partly on the basis of the technology which member firms, and potential member firms, brought to the table.

C. Profitability, Protection, and Industrial Policy

Profitability is difficult to achieve in markets where there is global overcapacity, price cutting, or dumping. Actions which would be considered "anticompetitive" under U.S. laws often occur in global markets or in the tactics of foreign firms competing with U.S. firms. This can lead to plant closures in the U.S. Sometimes lack of technology contributes to such plant closure. The U.S. needs to protect new start-ups in its consumer electronics manufacturing base against such threats.

Although it was argued that such issues require us to address broad issues directly, the discussion in Working Group A focused on industry-led strategies. It was argued that a basic issue--manufacturing capability and the need to encourage large-scale production--was of great importance.

D. Cost of Capital

The key role of the relative cost of capital among nations in influencing long term U.S. capital investment was noted. It was argued that if the cost of capital is 3.5 percent in Japan versus 11 percent in the United States, then the federal government must adopt policies that reduce the effective U.S. cost of capital in order for the playing field for U.S.-owned firms, at least in critical industries, to be level. One direct consequence of higher costs of capital to U.S. firms is that they must focus on short-term opportunities where the differential cost of capital is less important. What appears as a "lack of vision" by U.S. firms is really a rational economic response to the higher cost of capital that they face.

E. Market Access and Corporate Strategy

It was noted that the Japanese pattern for introducing new technologies is to test them and to build scale in the domestic market, and only then to shift to production for export. It was argued that Japan is tending to integrate with the rest of the Pacific Rim, and that this market is partially closed to the U.S. The European market also shows signs of closing in part, thus potentially leading to three major free-world economic blocs. Concern was expressed that such blocs could seriously influence corporate strategy and even lead to economic warfare among the blocs--or worse.

F. Government Purchases

It was suggested that military and government use of flat high resolution screens and related components over the next ten years could rival the U.S. non-governmental market. Consensus on this issue was not tested, but it is true that federal and state budgets do represent a significant fraction of the U.S. economy.

G. Initial Evolution of the HDTV Market

It was suggested that one avenue of entry to the HDTV market could be via advanced work stations, initially for military, business, and related markets. At the moment flat screen displays are being driven by laptop computers and watches. Advanced work stations could constitute an infant industry that would lead the U.S. back into HDTV. Alternatively, the HDTV market could be entered via the natural evolution toward advanced television, for which improved flat screen displays and advanced semiconductor technology would be key elements.

H. Industry-Government Relations

There was support for a structure that provides for government-private interactions on a broad basis. There was consensus that such a strategy which provides for corporate diversity and initiative and with the government providing a supportive climate was preferable to other alternatives considered.

There was also recognition that the nature of such consortia will necessarily evolve as experience is gained and as broader understanding of the issues develops. Considerable support was expressed for the efforts of the American Electronics Association in this area and for Sematech as an early first step. Support was also expressed for patent pooling as one of the mechanisms for strengthening the economic integrity of such consortia.

The objective of such consortia would be to ensure that U.S. firms have meaningful U.S. productive capacity at all levels in the technological food chain. It was felt that there should be vigorous domestic competition and market expansion, and that governmental and private measures may be required to promote equality of access and protection in international

markets. Most important is that the U.S. effort must be industry-led and that more major U.S. corporations must come forward and participate. The interests of both the Department of Defense and the Department of Commerce are involved and both should participate in this area, principally in support of critical research and development where high risks preclude adequate private U.S. investment. DARPA (DOD) and NIST (DOC) were cited as two relevant agencies for this purpose.

I Links between Technology and Production

Sematech was seen as an important first step in establishing precedence for corporate cooperation in integrated research and development efforts. One problem with Sematech is that if it should design new manufacturing equipment there may be too few U.S. firms to purchase it. The importance of design for manufacturing was noted. The industry-led consortium strategies discussed in this workshop differ from Sematech in that 1) there is much more emphasis on ensuring that any cooperative research and development is competitively linked to manufacturing, and 2) members of the consortia would include firms that are competitors.

J. Trade

All agreed that it is critical that the U.S. government enforce existing trade laws, including effectively protecting against dumping and providing reciprocal access to markets. It was suggested that the definition of dumping should be reexamined and perhaps should be based more on relative prices. It was noted that if the U.S. domestic market were effectively defended against unfair practices and imbalances in capital costs, the market would become much more attractive to American investors, and U.S. firms would be more eager to invest.

IV. Issues Addressed in Working Group B: Standards and Services

A Agenda

The agenda for the working group was:

- 1) Open Architecture Receivers
- 2) Standards and Control of Markets (proprietary technologies)
- 3) Immediate Standards Issues
- 4) Vision Statement

B Open Architecture Receivers (OAR)

An open architecture receiver has a generic modularized structure that facilitates its ability to handle multiple standards and to be upgraded. For example, it might support multiple transmission or display standards. The ease with which such receivers could handle multiple standards and evolve as technology evolves without requiring immediate replacement is a major advantage, but it requires that multiple standards constitute a "friendly family". Multiport receivers can also handle more than one standard but generally would not be upgradeable as standards or owners' preferences change. Poorly chosen standards make interconversion between standards more difficult and expensive.

The issue of cost and complexity of an OAR was raised immediately as a potentially serious obstacle. The lack of data on the costs and trade-offs for both open and closed designs for HDTV and other high resolution systems was noted. Nevertheless, it was argued that OAR concepts were technically and strategically promising and that user-friendly low-cost OARs may be feasible. For example, an extremely simple (and inexpensive) "naked" OAR could be upgraded by adding small plug-in chips or boards. It was agreed that OAR is not the same as Open Network Architecture (ONA), a regulatory "architecture".

After some discussion it was generally agreed that:

- The flexibility of an open bus structure, responsible for the success of the Apple II, IBM PC, and Sun workstations, holds promise for the design of flexible dual-use high resolution systems such as HDTV OARs.

- Cost analyses of open architecture versus multiport designs should be performed.
- An OAR would greatly help the US compete internationally in high-resolution systems markets.
- A low-cost user-friendly OAR is critical and probably feasible.
- Preparation of a short document "Questions and Answers concerning the potentials of OAR" would be useful in educating concerned parties.

Some historical perspective was provided by noting that Dumont had advocated an open architecture receiver (with flexible scanning standards) as an alternative to the closed-architecture NTSC standard in the early 1940s. Dumont's proposal was rejected by the Radio Manufacturer's Association on the grounds that Dumont (subsequently a major TV manufacturer) was not a radio manufacturer, and therefore had no standing to participate in standard-setting for television.

As a side note, similar pressures in the standards process were alleged in the current debate concerning potential U.S. and global adoption of the NHK 1125-line production standard. One of the key HDTV standards issues involves use of interlace instead of progressive scan. Cited as being illustrative was a key meeting of the Society of Motion Picture and Television Engineers (SMPTE) on February 17 and 18, 1985 which addressed this issue extensively. Several votes were taken as the meeting progressed. For the first vote 17 participants voted for progressive scan, while only 4 (3 from CBS affiliates and one from Sony) voted for interlace. Nonetheless, at this meeting the minority position was eventually adopted, partly on the allegedly mistaken belief that time pressures forced adoption of the first (and only) standard then available. US manufacturing firms then had no strong technical initiatives or interest in this area, and appeared to have abdicated. At the meeting of March 19, 1985 of the Advanced Television Standards Committee (ATSC), originally formed by the EIA, NAB, SMPTE, and IEEE, a separate vote was taken with the result that 21 favored the NHK standard, 14 were opposed, and 6 abstained. Although this fell short of the two-thirds needed to formally approve the NHK standard, it again emerged with SMPTE endorsement as there were no U.S. firms in a position to develop or promote the preferred progressively scanned alternative. It was suggested, however,

that there may be at least one U.S. patent of some use if the NHK production and related MUSE transmission standard are adopted⁵.

It was further alleged that foreign interests now dominate the ATSC to a degree that should disqualify it from a central role in US policy making. It was agreed that if inappropriate pressures in the US or in the ITU's CCIR Study Group 11 on HDTV actually existed and could be documented, the results would be of broad interest.

C. Proprietary Technologies and Standards

The first question discussed was whether it made a difference which standard the U.S. uses. It was agreed that the answer was yes, it does make a difference. It was noted that if it did not, the proponents of the 1125-line 60-Hz interlaced production standard would not continue working so hard to have it adopted in the U.S. and endorsed as the single global standard by the CCIR, and the Europeans would not be opposing it so strenuously--they favor 50-Hz progressive scan with a different number of lines. While no government action can guarantee market success, the adoption of 1125 could help preclude U.S. manufacturing firms from succeeding in related high resolution markets because of the Japanese lead on the 1125 learning curve and in related patents. An asymmetry in present national standards setting and trade policies in these areas was noted. Conclusions reached include:

- **Open architecture does not mean non-proprietary. The U.S. could support open architecture designs, and also seek to develop proprietary positions in high resolution systems technologies.**
- **The most protectable element of an OAR was expected to be special chip sets and algorithms, including encoding and decoding techniques.**
- **The U.S. can not always depend on patents and licenses for critical technology from Europe or Japan, whereas foreign firms can usually count on such licenses for U.S. technology at open market prices.**
- **There was no compelling reason for the United States to**

⁵ Rossi, "Method and Apparatus for PCM-Encoding NTSC Television at Sub-Nyquist Rate"; US 4,065,784, December 27, 1977. See also NHK Laboratories Notes 235 (T. Yoshino and A. Ohya) and 304 (Y. Ninomiya).

continue to inflict economic damage on itself by perpetuating asymmetries in technology trade policy.

Discussion shifted to patent pools and technology licenses for U.S.-owned firms participating in high-resolution systems consortia. The computer industry's practice of maintaining a second source of supply, e.g. for semiconductors, was judged worth emulating by the current initiative. It was suggested that the rights to licensed technology should revert to the industry consortium if a member firm is sold. On the issue of foreign participation it was agreed that a consortium should be open on a reciprocal basis. Opportunities for cross-licensing technology needed by the consortium, and the operation of research and development and manufacturing facilities in the U.S. were agreed to be some of the factors to be taken into consideration in determining which firms should be permitted to participate in a consortium. The working group agreed that:

- **Adoption of efficient manufacturing technology and productive management techniques (such as work teams) to ensure high product quality and reliability were recognized as being just as significant as standards in determining whether U.S. reentry will be successful.**
- **Even if the technology is designed and a proprietary position is held in the U.S., those with better manufacturing capability may design around the standard.**
- **Thus, the U.S. must go beyond a focus on technology, to consider such issues as management and manufacturing techniques, labor relations, trade policies, and the cost of capital.**

D. "Friendly Family" of Standards

High resolution systems for program production and program interchange will be completely different from present systems and will require different technical standards. The difficulty of transcoding interlaced 1125 (of repacking data from one video format to another) was noted. Such repacking, however, is needed for program interchange and production of HDTV. 1125 interlaced therefore poorly satisfies the requirements for the functions it is proposed to fulfill. It was noted that the original study question of HDTV in the CCIR concerned satellite broadcasting, for which 1125 interlaced (and MUSE) is better suited than it is for production, terrestrial

broadcasting, or cable transmission.

Adoption of a "friendly family" of high resolution and HDTV standards was considered important for the production of low-cost open-architecture receivers.

It was suggested that, from a technical point of view, the proper sequence of standard setting is first to choose the receiver and then to set standards for transmission and production--the reverse order from that followed in the current CCIR work on HDTV standards.

E. Immediate Standards and Technology Issues

Asymmetries in U.S. practices relative to Europe and Japan were again noted. It was argued that the Japanese and Europeans have always better understood and exploited the international economic impact of standards, while the U.S. has traditionally emphasized the assessment of international standards on technical grounds.

It was suggested that there may be a Japanese strategy of "giving away" the rights to the 1125 production standard, while later not so freely licensing the closely related MUSE transmission standard and technology in which Sony, NHK, and perhaps CBS were thought to have proprietary interests--such a strategy might lead to control of the receiver market. It was stated that a U.S. high resolution systems consortium should adopt a similar strategy, but based on a different standard. With regard to a U.S. consortium it was agreed that:

- Decisions will be made in the next few months on critical standards issues affecting the interests of such a consortium.
- Other nations and their firms are coordinated in this area, but U.S. manufacturers are not.
- Such a U.S. consortium must have the capability to respond and participate significantly in standards forums.

Some of the principal standards forums and parties currently active in HDTV standards setting include:

CCIR	International production, program interchange, broadcasting, and satellite broadcasting standards
FOC	U.S. broadcasting standards
ATSC	U.S. broadcasting, production, program interchange standards for advanced television systems
SMPTE	U.S./international production standards
Cable Labs	U.S. cable transmission standards
Industry	Production, program interchange, broadcasting, satellite broadcasting standards (e.g. Zenith, NBC, RCA, Thomson, Sarnoff, Del Ray, Philips, Sony, CBS, AT&T, IBM, Bellcore, etc.)
DARPA	Technology support for high resolution systems
Eureka 95	European production, program interchange, broadcasting, satellite broadcasting
NHK	Japanese production, program interchange, broadcasting, satellite broadcasting
University	High resolution systems standards (MIT, NYIT)

Those potentially more active in high resolution systems standards setting include additional private firms and universities, plus:

CMTT	CCIR/CCITT international television broadcasting and terrestrial transmission joint working group
ISO/IEC	Private international voluntary electrical and electronics high resolution systems standards
DOC	NIST/NTIA
U.S. Consortia	High resolution systems and transmission standards
T1	High resolution transmission standards

F. Vision Statement

In contrast to the other subjects the working group addressed, consensus on a vision statement was not reached. It was agreed, however, that:

- One goal is to facilitate the emergence of "American entities manufacturing television systems with American parts, labor, and knowledge."
- It would be sensible for a TCA to emphasize products people will want, such as flat screen TV's.

- To develop a clearer vision of advanced television and to understand the demand for advanced television systems and services, thorough and sophisticated research on video communications systems will be required.
- Programmers, network operators, and cable television firms should be involved, so that realistic prototype services could be tested.
- Research on high resolution systems and broadband networks should also be conducted in testbed demonstration projects and subsequently in larger pilot projects.
- Consortia should develop displays, semiconductors, and possibly entire systems.
- Demonstration and pilot projects should be open to foreign participation on a reciprocal basis.
- As federal law prohibits more than 25 percent foreign ownership of U.S. broadcast facilities, for national security reasons, foreign participation in U.S. high resolution systems broadcast demonstration and pilot projects would therefore presumably be restricted to no more than 25 percent.

V. Issues Addressed in Working Group C: Technology and Manufacturing Capabilities

A. Technology Status

After discussion of the objectives of the working group, the group began by listing technologies relevant to the manufacture of high-resolution video displays. These technologies were divided into two categories, those for which the U.S. was believed to have a meaningful manufacturing base and those for which it does not. These two lists are presented in Figure 3. The relative sums of money needed to establish a meaningful U.S. capability in each of the relevant technologies was estimated, and those technologies deemed to require the largest investments were DRAMs, displays, manufacturing science and technology (including robots), and optics. In some cases it was felt that the technology was obsolescent and that such investment might be misplaced, e.g., deflection yokes for CRTs. It was felt that a central effort would be required even to maintain those technologies we do have

against the competitive pressures posed by the concerted efforts of certain overseas competitors. That is, it was generally felt that almost no technology was safe.

Figure 4 presents a list of merchant vendors of integrated circuits with a separate listing for applications specific integrated circuits (ASIC). Another list characterizes the leaders in IC interconnects and the situation in IC packaging materials. Additional areas where the U.S. is losing its markets are also presented. It is clear from these lists⁶ that the U.S. is not the leader

Figure 3. High Resolution Systems - U.S. Technology Capabilities

Technologies ⁷ We Do Not Have	Technologies We Do Have
Displays	Systems Integration
Yokes	Software
DRAMs	Digital Logic
Digital GaAs	CPUs
Low-End Print Engines	ASIC
Materials	Microprocessors
Packaging (Semicond.)	CAD/CAE/CASE
Test Equipment	Large Family Rooms
Photo Lithography	
Manufacturing S&T	
Optics	
CCDs/Imaging Devices	
Mechanisms	
OEIC (Opt.-Electron. ICs)	

in any of these areas, and in emerging technology areas the situation is even more precarious. The linkages between materials, IC packaging, and multichip modules represent a particular vulnerability for U.S. semiconductor manufacturers. It was noted that firms are extremely reluctant to reveal or discuss their weaknesses in public.

⁶ Provided by H. K. Bowen.

⁷ Technologies for which we have competitive state-of-the-art low-cost manufacturing capabilities at scale.

Figure 4. Leading Vendors (in order of market share)

Total IC's	ASIC	IC Interconnects, High performance multichip modules	U.S. Losing Markets, Examples
NEC	Fujitsu	IBM	Si crystals, wafers
Toshiba	Toshiba	NEC	IC's
Hitachi	NEC	Fujitsu	Capacitors
Texas Inst.	AMD	Hitachi	Varistors
Intel	LSI Logic	Kyocera	Cutting Tools, etc.
Motorola	TI		
Fujitsu	Motorola		IC Packaging Materials:
National Sem.			Japan supplied 40% in
Mitsubishi			1978 and 80% in 1988
Philips			

B Technology Linkages

The importance of the linkages between different technologies was stressed. Public understanding of these linkages would increase support for U.S. initiatives in this area, and would provide a better sense of how the industry should focus its efforts, expand its breadth, and establish the desired scale of manufacturing capability.

C Manufacturing Equipment

A significant opportunity for productivity enhancement was suggested. U.S. firms purchasing sophisticated manufacturing equipment often keep improvements they make to that equipment proprietary so that competing U.S. firms must either re-invent these improvements or do without. Although Sematech might be able to improve this situation for some types of manufacturing equipment, the problems and opportunities were felt to be much broader.

D The DARPA Initiative

It was understood that DARPA, an advanced research and development arm of the Department of Defense, has an initial 30 million dollars allocated to support of high resolution displays and image processors but that it will not initially address either cameras or video recording. It is hoped that this

budget will be increased and that venture capital will be available to supplement promising proposals. An area of emphasis for image processors will be semiconductors and other means for handling video signals within a nominal bandwidth such as 6 MHz. The objective is to help enhance the integrity of the U.S. manufacturing base relevant to these dual-use technologies. Proposals were due February 27, 1989, and the level of activity has been high. The working group commended DARPA for its effort and agreed that it had selected two of the most important areas to fund. The importance of DRAMs and displays were both noted as being critical ingredients in future HDTV systems.

E. Business Issues

It was felt that part of the business problem is the limited incentive to capitalize, particularly in long term investments. The enormous impact of pension funds and insurance companies on the investment climate was noted; it is essential to make it attractive for them to invest in these technology areas. The importance of lowering the relevant U.S. cost of capital was noted and that lowering capital gains taxes on technology investments might be very helpful; it was argued that in providing such tax preferences, such as lower capital gains taxes, the government should single out manufacturing investments rather than including less production-oriented forms of investment such as general real estate. In particular it was felt that the government should be a catalyst in getting high resolution system technology (including HDTV) started in the U.S. The importance of progress in displays was noted, and this was an area in which the U.S. might be able to excel.

F. Consortia

The purpose, forms, and functioning of consortia as a means for advancing technology were discussed.

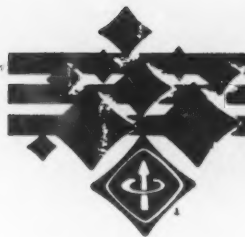
Examples of consortia considered included one working on high resolution systems, and perhaps another concentrating on manufacturing and machine tools, including milling, casting, welding, lithography, etc. One suggestion was that a high resolution system consortium might embrace components for work stations, memories, television, HDTV, radio, and other low cost or related consumer electronics products. Alternatively one consortium might focus specifically on DRAMs, another on displays, etc. The

relative advantages of these approaches was not resolved. The possibility of establishing a more end-product oriented consortium was also noted. Such a consortium, for example, might develop a combination TV/PC.

It was noted that Japan utilizes MITI to do long term projections, even 50 years in advance, whereas we seldom look even 10 years into the future. There was some concern expressed that Sematech may be too heavily focused on yesterday's problems and not sufficiently strongly oriented to the future. Such long term projections could be one of the functions of a consortium. A contrary view was that one becomes a leader by innovating rather than by doing 50-year plans. It was felt that short term planning and milestones were nonetheless an important function of a consortium or its members.

The sources of competitive advantages of a consortium relative to isolated firms were felt to include cooperative R&D, government relations, information and patent exchanges, and greater success for governmental relations in such matters as loan support, discussions and rulings concerning accounting and tax credits, trade regulations and enforcement, assured markets through government purchases, and improved communications concerning trade violations, tariffs, impact of subsidies, and other forms of government regulation. Other areas of cooperation between firms might include studies of legal, political, market, standards, competitor evaluation, and personnel issues, and other areas. Information sharing with universities, government institutions, and other firms would be facilitated, and might extend to better awareness as to available intellectual, manufacturing, technology, and other resources.

It was felt that the potential impact of such consortia would be difficult to establish in advance, but that it could be significantly positive, and their establishment should therefore be pursued creatively and aggressively.



ENTITY POSITION STATEMENT

A NATIONAL INITIATIVE FOR THE ELECTRONICS INDUSTRIES

The Institute of Electrical and Electronics Engineers, Inc.

1111 19th STREET, N.W. WASHINGTON, DC 20036-3690
(202) 785-0017

- *The U.S. must immediately re-establish significant technological capability and domestic manufacturing of world-class products by U.S.-owned firms based on electronic and related technologies that serve both civilian and military purposes.*

- *The situation is critical. A proactive stance by the Federal Government is required if these goals are to be achieved.*

- *A cooperative organization structured to function in the private sector, but with Government support, is an appropriate initial vehicle for implementing these goals in this country.*

- *The organization and its Government support must be in place this year.*

- *In the longer term U.S.-owned domestic manufacturers must be able to perform profitably in global markets over a broad technology base under conditions of true economic competition.*

- *This IEEE Council can assist in catalyzing the achievement of these goals by convening working sessions in the immediate future and providing appropriate support throughout the process of implementation.*

TECHNOLOGY ACTIVITIES COUNCIL

JANUARY 25, 198

Approving Entity

Date

Today progress in electronic process technologies, cost efficiencies, and product quality are determined more by the demands from large scale consumer markets such as those for television, computers, and automotive electronics, than they are from military and space requirements. Linkages and spill-over effects are now becoming more prominent from the consumer sectors into the military, than they are in the reverse direction. The ability to design and manufacture sophisticated electronic and electromechanical systems is increasingly vital to a broad range of military and civilian products important to U.S. national security and to the future U.S. standard of living. Often technologies and components that are essential for civilian applications are identical to those vital for military weapons systems. Such "dual-use" items are also key elements in the evolving U.S. communications infrastructure upon which our economy and democracy depend.

The global consumer electronics market is now principally supplied from the Pacific Rim and to a lesser extent from Europe. The almost total elimination of U.S.-owned firms from domestic production of many dual-use products--and thus the loss of their design and manufacturing capability--represents a great danger to this country's military and economic security in areas such as computers, telecommunications, automation and modern weaponry. The necessity to purchase these products from foreign suppliers is contributing increasingly to the U.S. balance of payments deficit. As a nation we can no longer ignore these linkage and spill-over effects from consumer electronics to military and other national security areas.

Other countries have faced and overcome similar problems: there are lessons taught by their successes and failures that we must understand and incorporate into the process as the U.S. undertakes to reverse the current trends. The first lesson is that without the active cooperation and support of the domestic government, it is virtually impossible for a nation's industry to develop and maintain domestic capability in the face of well established, entrenched and aggressive competitors. U.S. Federal Government support, therefore, is essential as U.S.-owned firms become re-established and evolve to the level of global competitiveness.

An additional early conclusion from prior experience is that, given the U.S. economic system, a cooperative organization structured to function in the private sector is likely to prove to be the best vehicle for implementing initial development efforts. The actions of interested Federal Government agencies in support of such an initiative must be orchestrated and coordinated, and must include regulatory and trade actions, loan guarantees to help move capital costs toward competitive levels, and anti-trust clarifications to permit pilot manufacturing to prove design concepts. In addition, they must include cooperative projects among industrial research laboratories, universities, and U.S. Government laboratories. Progress toward the goals of the initiative must be continually evaluated and adjusted when and as necessary.

Consumer electronics, which include many of the most important and threatened dual-use technologies, are at a crossroad with further implications for the balance of trade. New sophisticated products—extended definition television (EDTV) and high definition television (HDTV)—at both the producers' and the consumers' levels are immediately on the horizon. Other nations are well ahead of the U.S. and are moving aggressively in their planning and development for these products. The Japanese are expected to make their first satellite test broadcasts with these products this year. The Europeans are also very active. Planning by U.S. industry is at an early stage.

Only if the U.S. establishes an independent presence now, will there be hope for the long-term recovery of this industry at a reasonable cost. Indicative of the depth of the problems this country faces in achieving this goal is the fact that the sole surviving U.S. television manufacturing firm is reported to be under serious pressure to sell this sector of its business. There is no likely U.S. buyer. The absence of strong U.S. voices with a major interest in the decisions even now being taken by the Federal Communications Commission and State Department—decisions that will determine the future of the U.S. market for decades to come—is likely to mean that foreign voices will determine their outcome.

The key goal of these initiatives for U.S.-owned domestic manufacturers is that they must be able to perform profitably with world-class products in global markets over a broad technology base under conditions of true economic competition. The implications of each step in the process of re-establishing and maintaining U.S. capability must be assessed against this longer term objective.

The IEEE is a professional society whose purpose is to promote and disseminate knowledge about the electrical and electronics fields, both in technology and technology policy areas. In the immediate future the IEEE-USA Technology Activities Council will sponsor workshops to bring its broad expertise and that of others to bear on these issues to help the nation generate an effective and timely action plan.

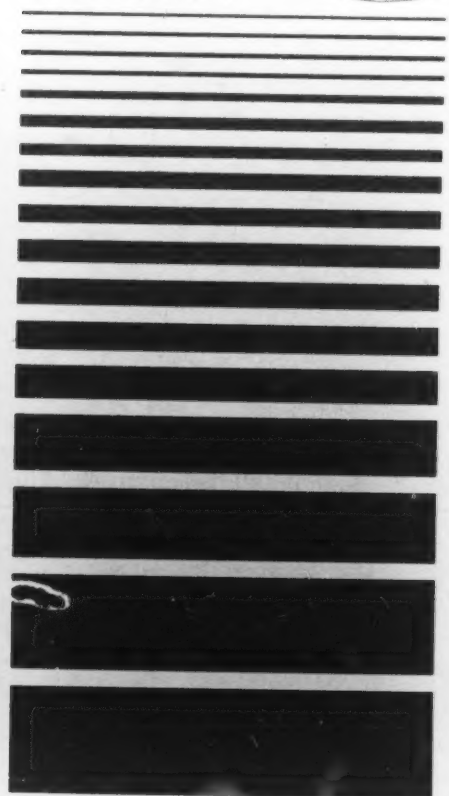
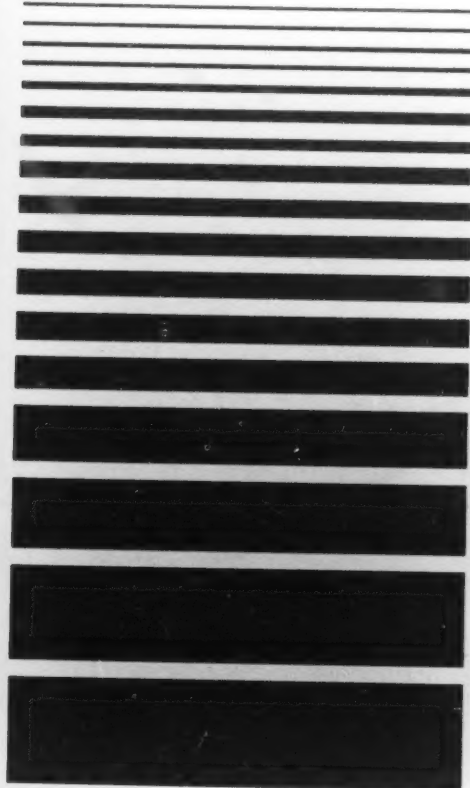
*Technology Activities Council
January 25, 1989*



Association of
Maximum Service Telecasters, Inc.
1730 M Street, N.W.
Suite 713
Washington, D.C. 20036
(202) 457-0980

HDTV

AND THE LOCAL
BROADCASTER



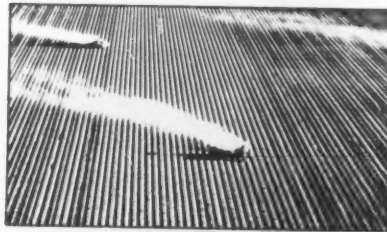
HDTV AND THE LOCAL BROADCASTER

High definition television promises a dramatic technological leap in video and audio quality. HDTV will bring pictures as sharp and clear as a picture (or 35mm film) on larger and wider screens, with improved color and digital sound.

► HDTV's Challenge For Local Broadcasters

HDTV's better pictures and sound come from improving the television signal, including nearly doubling its 525 scanning lines. The resulting HDTV signal will transmit over four times more information than our current NTSC system.

That much additional information cannot be easily shoehorned into the 6 MHz channel of spectrum allocated to U.S. television stations. Consequently, without access to additional spectrum, American broadcasters may not be able to participate in the next generation of audiovisual technology.



Other video services (cable, microwave, satellite, videocassette and videodisc) do not suffer the same spectrum limitation and could deliver HDTV signals as soon as new "advanced" TV sets come on the market. Japanese consumer electronics companies may introduce such sets, VCRs and videodisc players in the U.S. in the early 1990s.

Without the timely ability to match the HDTV quality delivered by non-broadcast means, our local broadcast system may be relegated to a permanent, and possibly fatal, second-class status.

► Key Role Of The FCC

In response to a request by MST and nearly 60 other broadcast organizations, the FCC initiated a wide-ranging inquiry into HDTV. At the same time, it put on hold a proposal to reallocate to land mobile services UHF spectrum which might be broadcasters' only hope for participating in HDTV.

The FCC also created an industry Advisory Committee on Advanced Television Service to investigate HDTV. The Committee's interim report was issued in June 1988, with a final report expected in the fall of 1989.

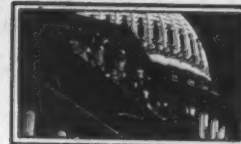
► Quality of HDTV Service

Some twenty different HDTV systems have been proposed for broadcaster use. Some are compatible with today's receivers, while others are not. At the request of the FCC Advisory Committee, these systems will be tested for local broadcaster and cable use by the broadcaster-funded Advanced Television Test Center.

The proposed systems vary significantly in quality, ranging from relatively minor advancements in the current system to "full" HDTV (twice the resolution, one-third wider screen, substantially better color, and digital sound). The



NTSC Receiver



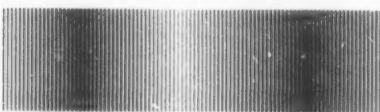
HD Receiver

key objective of broadcasters is to select a system that provides quality equivalent to that offered by competing media in both the short and long term.

► More Spectrum Needed

The overwhelming consensus is that broadcasters must use more than their present channels to equal the quality provided by their competitors—and demanded by tomorrow's viewers. Preliminary studies indicate there may be enough VHF and UHF spectrum available to provide existing broadcasters with an extra 3 or 6 MHz, but only if the HDTV system can tolerate much more, and create much less, interference than the current NTSC system.

If enough additional spectrum can be made available, broadcasters might have the option of using either a compatible or incompatible HDTV system.



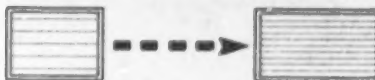
A typical compatible approach envisions a "smart" HDTV receiver adding two signals together to yield a high definition picture while existing sets continue to receive the current single-channel NTSC signal.

An incompatible approach also would use two channels. One would continue to provide NTSC to existing sets. The other would provide high definition service to new sets. This "simulcasting" approach was used when FM radio was introduced and the same programs initially were carried by different AM and FM channels. This approach holds the promise of long-term spectrum efficiency, whereby spectrum used for NTSC signals ultimately could be returned for government reallocation to other uses once a large majority of consumers had made the transition to new sets.

► Transition to HDTV

Assuming that competitive broadcast HDTV cannot be accomplished on a single, NTSC-compatible channel, there are three primary transition scenarios for achieving HDTV:

■ **One-step transition.** Broadcasters would install the necessary equipment at one time to transmit a compatible HDTV signal, using additional channels or half-channels if available.



■ **Two-step transition.** Broadcasters would make quality improvements within their current channels on a compatible basis as a first step, phasing into higher quality by adding channel capacity at a later date.

■ **Simulcasting.** Broadcasters would transmit the same programming on separate HDTV and NTSC channels.

► Economic Considerations

If broadcasters can surmount spectrum constraints, the introduction of HDTV will be costly. In the worst case, broadcasters face the possibility of totally replacing their existing studio and production equipment. It is likely they will have to operate two transmitters at some point.

Consumer equipment also will be more expensive before production economies of scale are reached. Early estimates of HDTV receiver costs range from \$2500 to \$3500. HDTV VCR costs will also be higher than current VCRs. These costs are unlikely to vary much regardless of which HDTV system broadcasters use.

Given the international economic stakes involved, Congress, the Administration and the FCC Advisory Committee are looking to enhance American industry participation in the new generation of consumer electronics manufacturing and marketing.

► Improvability

All of the HDTV systems which have been demonstrated thus far over broadcast channels as well as over satellite, cable and fiber optics preserved spectrum by compressing HDTV signals. Even higher quality is provided by uncompressed HDTV, called a baseband signal, which requires five times the bandwidth of broadcasters' 6 MHz channels. Baseband VCRs and laser disks likely will be marketed in the near future.

With the introduction of fiber optic cable, cable systems and possibly telephone companies also will be able to deliver uncompressed HDTV signals directly to the home.

Hence, broadcasters cannot afford to settle for an HDTV system which may be good enough for tomorrow but cannot compete with the base-band HDTV of the day after tomorrow.

► Cable's Views Of HDTV

Today, over half of broadcasters' viewers receive their programs via cable and most viewing in cable households is of broadcast signals. Clearly, broadcasters and cable system operators have a strong mutual interest in broadcast HDTV standards that are compatible with cable carriage. Although cable operators theoretically enjoy unlimited spectrum, they are concerned that an HDTV system requiring more than one 6 MHz channel could cause expensive technical problems and require many limited-capacity systems to be rebuilt.

On the other hand, cable operators are also concerned that they have the ability to select an HDTV format that is optimal for their industry, realizing that they need to compete with the quality of services offered by fiber optics, video-cassettes and satellite-delivered programs in the future. Hence, they do not want cable precluded from moving to higher-quality systems by the HDTV system selected for broadcasters. DBS and VCR interests similarly oppose broadcast standards which might hinder their achieving maximum potential technical quality.



► U.S. Policy Considerations

The central question confronting governmental decisionmakers is how to address the changes in the nation's communications structure foreshadowed by HDTV. While HDTV promises dramatic improvements in television quality, it also threatens the long-term health of our U.S. broadcast system based on free and universal reach and local community service.

The FCC ultimately must decide whether to grant broadcasters sufficient spectrum to remain competitive with other media.

Congress has begun to investigate both the potential impact of HDTV on the nation's locally oriented mass-communication system and its implications for our balance of trade and ability to maintain a competitive position in new technologies.

► Planning For The Future

Local broadcasters are determined to participate in the evolution to high definition television and the video delivery technologies of the 21st century. The core question that must be addressed by broadcasters now is how high their quality must be for them to remain technically competitive during the transition to HDTV and into the future.

That question must be answered correctly as soon as possible and lead to the implementation of an HDTV system that preserves and enhances the quality of our unique American locally rooted, universally available and free system of broadcasting.



ASSOCIATION OF
MAXIMUM SERVICE TELECASTERS, INC.
1730 M Street, N.W., Suite 713
Washington, D.C. 20036
(202) 457-0980

March 31, 1989

The Honorable Robert A. Roe
House Committee on Space
Science and Technology
Rayburn House Office Building
Washington, D. C. 20515

APR 4 1989

Dear Mr. Chairman:

I congratulate you on your leadership in the recent hearings on HDTV and the profound and revolutionary consequences associated with its development.

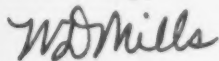
I have been closely associated with the Company's Direct Broadcast Satellite (DBS) and related HDTV and Educational initiatives for more than six years.

The continued progress and enormous promise offered by this exciting new technology with its many applications, benefits, and services for the nation is the most compelling opportunity that I have seen.

I understand our respective staff members have spoken and requested the attached paper for inclusion in the printed record of your recent hearings. We look forward to visiting with you, members of the Committee, and/or your staff at an appropriate time regarding the enclosed program.

With kindest personal regards and best wishes, I am

Sincerely,



Wilbur D. Mills
Chairman

cc: President George Bush
Members of the Committee
Jim Turner

ADVANCED COMMUNICATIONS CORPORATION

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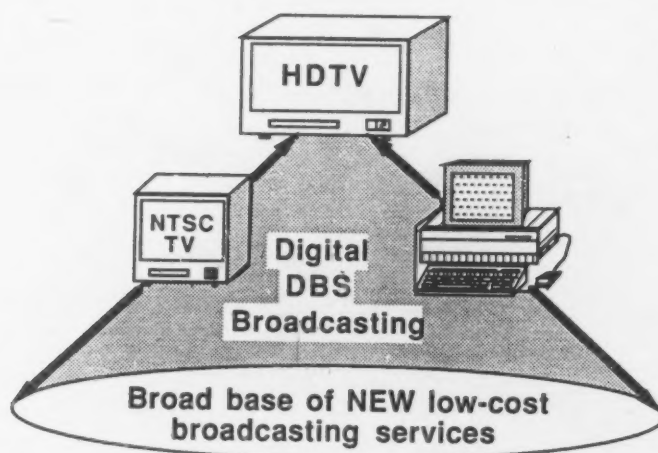
Advanced Communications Corporation



March 1989

HDTV, DBS and Education*

Prepared for:
The United States House of Representatives
Committee on Science, Space and Technology
The Honorable Robert A. Roe
Chairman

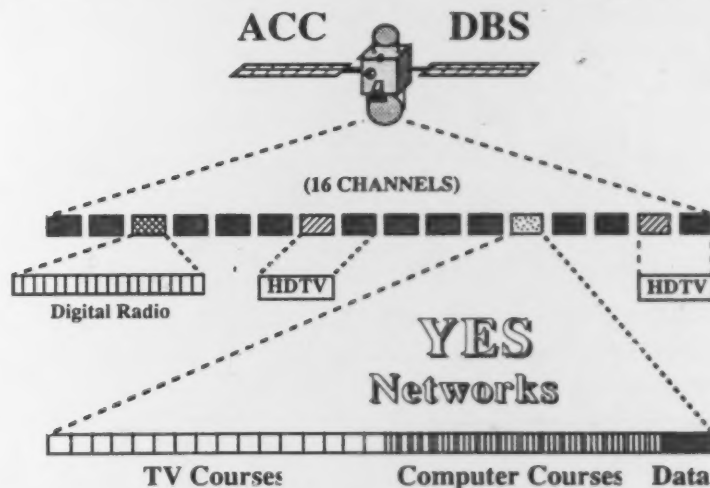


* High Definition Television, Direct Broadcast Satellites.

Summary

America's educational shortcomings and America's ability to compete in the upcoming High Definition Television (HDTV) market are compelling issues of national concern. Educational deficiencies in math, science and technologies are the root of our escalating problems in competing with an increasingly technologically oriented world. At the same time, the technological dilemmas presented by the inevitable market transition to HDTV present an unprecedented opportunity to mold this technology and achieve a quantum leap in the universal availability of quality educational programs and services.

Direct Broadcast Satellites (DBS), such as those of Advanced Communications Corporation (ACC), using digital transmission and reception designed by Advanced Communications Engineering, Inc. (ACE)¹, will deliver compatible TV and HDTV (regardless of the yet-to-be-chosen format standard) to inexpensive 2' dish antennas anywhere in the nation. The same technology and hardware used in HDTV sets can be used for reception of new types of services. The YES (Your Educational Services) Networks is a totally new concept in educational services offering over 100 simultaneous video courses (plus auxiliary materials) where only one TV course has been possible previously.



¹For further information contact Daniel H. Garner, ACC, 6803 Cantrell, Suite 200, Little Rock, AR 72207 (501-377-1493), or G. Gordon Apple, ACE, 722 S. Broadway # 30, Redondo Beach, CA 90277 (213-540-6532).

Critical Needs in Technology and Education for the United States:

First, the United States of America is rapidly losing its leadership in the areas of science and technology, in which it was once the undisputed leader and envy of the entire world. As noted in many recent studies, science and technology provide the basis of our economy and well being, the strength of our defense, and even the hope of the planet. Superior education, especially in math and science, is absolutely essential to the nation's future vitality and defense. However, the nation's schools have declined to a point where former Secretary William Bennett described some as reaching "total melt-down."

The critical need to reverse this decline and offer quality education to everyone (including adults), regardless of their present status or living area, is the basis of this paper. While we must teach the students, where will we find the teachers? Qualified science teachers are rare. Qualified mathematics teachers are virtually non-existent in many school systems. A recent study¹ repeatedly emphasizes the need and the lack of teacher training in the effective use of technology. The solution lies in the judicious use of our available electronics technology to increase the availability of high-quality instruction (Master Teachers) and innovative learning techniques.

Second, commercial electronics technology is rapidly advancing and is having a substantial impact on the economies of nations and their defense capabilities. A concern recently receiving much attention is that the next generation of television systems (High Definition Television, or "HDTV") will be dominated by the Japanese and others. The realization that these new televisions are packed with digital computer-type electronics has even prompted the U.S. Dept. of Defense (i.e., DARPA) to become significantly involved in this technology in the hope of salvaging the remaining U.S. integrated circuit industry and preventing foreign domination and U.S. dependence on related computer technologies.

To insure orderly transition to HDTV, the FCC decreed that terrestrial broadcasts in the U.S. be "compatible" with existing TV broadcasts. HDTV inherently is a huge user of valuable and limited radio spectrum, requiring about five of today's standard TV channels. A multitude of new transmission standards have been proposed for "compressed" HDTV that instead would only occupy one or two standard TV channels.

¹ "Power On! New Tools for Teaching and Learning," Congress of the United States, Office of Technology Assessment, OTA-SET-379, September, 1988.

Any new TV standard will require new TV stations, transmitters and other major investments in all the major metropolitan areas. Service area "critical market mass" must be derived from individual local broadcast areas. Even so, HDTV via terrestrial broadcasting will not be available for a long time, if ever, in many remote areas. The inevitable transition to HDTV would be much smoother and more rapid if a means were available to initially reach all areas (urban and rural) of the country simultaneously. This also would guarantee a uniquely American system that would place U.S. industry on at least an equal, if not advantageous, footing with foreign competition.

Ways and Means to Solve Both Problems (and others):

DBS/HDTV: A few years ago, the ITU (International Telecommunications Union), through its mechanisms of conferences (1977 World Administrative Radio Conference, and 1983 Region 2 Administrative Radio Conference) established international agreements for satellite orbital locations, radio frequencies, and ground coverage areas for a new type of satellite television service called "Direct Broadcast Satellites" (DBS). These are high-power satellites which provide a signal strong enough to be received with a user antenna less than two feet in diameter in a system costing only a few hundred dollars. The FCC has been active in support of this new public benefit, assisting in clearing frequencies, setting standards, and granting several DBS satellite construction permits.

When these permits were issued several years ago, it was assumed that the service would use analog transmission. However, as the advantages of digital transmission and signal processing became more pronounced and apparent, one DBS permittee, Advanced Communications Corporation (ACC), proposed to use totally digital transmission to bring these efficient, modern capabilities into many needed applications. Advanced Communications Engineering, Inc. (ACE) was formed for the purpose of providing the systems engineering, designs, and hardware necessary for implementing digital DBS transmission and services.

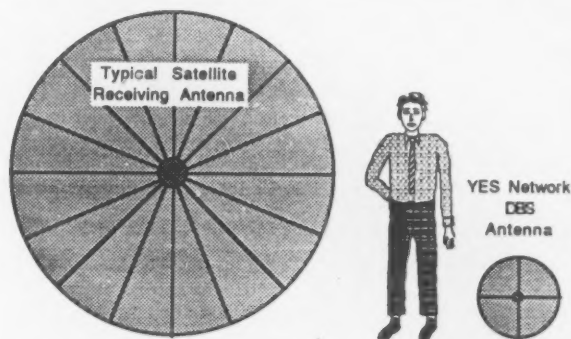
Although DBS originally was envisaged as a medium for standard (analog) television transmission, digital DBS is an obvious medium for making HDTV instantly available throughout the entire nation. Any satellite receiver requires signal conversion circuitry for use with a standard TV receiver. The flexibility of digital transmission and processing will allow DBS HDTV to be totally compatible with today's standard TV, while also being compatible with any terrestrial broadcast standard for HDTV that may be issued.

Because DBS service will draw its market from the entire nation, it will be much easier to get an early "critical market mass" than would terrestrial broadcast in establishing the U.S. HDTV market.

HDTV sets are internally much like computers or workstations containing digital processors and computer memories. On the other side of the coin, today's personal computers are becoming more like advanced TV sets or even HDTV sets. There is a rapidly growing use of personal computers to create, output, control, and modify TV images. Seminar and classroom presentations are being created on computers and then presented directly by projection or on TV screens, often with animated graphics.

Innovative Education Today: There are two significant trends in today's education. One is the innovative and very effective use of computers and laserdisks at all levels of education. When used properly, computers and computer-controlled laserdisks can vastly enhance the student's learning experience, ease the teacher's workload, and provide totally new teaching and administrative tools. Unfortunately, there are too few classroom computers and even fewer teachers that are adequately trained in their usage.

The other trend is a rapid increase in "distance learning." This term covers everything from microwave remote-campus TV lectures to telephone lines carrying voice and electronic blackboards, or even electronic computer bulletin-boards for students to ask questions of their instructors. Several universities, some international groups, and many corporations are using satellites for very effective TV distance learning.

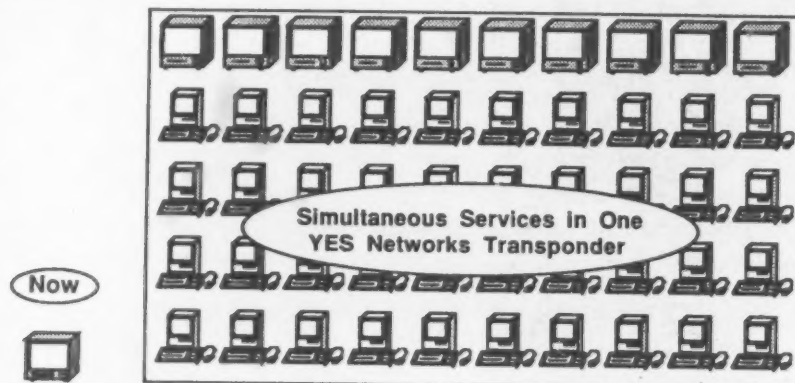


Present Antennas vs YES Networks DBS Antenna

However, satellite systems today are very expensive, both for satellite transmission (transponder) time and for the ground receiving terminals which include a permanently mounted 8- to 12-foot dish. Recently, satellite distance learning has increased substantially in the public school sector, especially prompted by last year's U.S. Dept. of Education "Star Schools" program. Existing systems include Los Angeles County's Educational Telecommunications Network (ETN), a satellite system installed

mainly for teacher training. Distance learning is effective and in many cases is the only means available to offer minimum required courses and/or optional advanced courses.

The YES Networks, the proposed system to establish new learning opportunities, will use digital DBS together with computer assistance techniques to allow simultaneous nationwide presentation of up to **100 or more** formal courses to **all of America's schools and homes** — each offering innovative educational services that are not possible by other means (e.g., traditional instructional television and computer networks) with each providing essential enrichment for rural and minority students.



A Comparison of Educational Services -- Present vs YES Networks

All this can occur in a **single** DBS satellite TV transmitter (transponder) which, using conventional techniques, could carry only a single video course. Reception will be by means of the same **inexpensive 2-foot antenna** used for DBS TV. Display will require a personal computer, HDTV, or TV adaptor. Optionally, distribution to additional projectors or monitors can be provided. Supplementary materials (e.g., reading, programmed learning assignments, homework, exams) will be "downloaded" to the students simultaneously during the broadcast lecture using the same channel and equipment.

This nationally-broadcast and widely-received system will serve as the obvious means to coordinate national educational enhancement programs such as that proposed by the NCTM¹ and other

¹ "Curriculum and Evaluation Standards for School Mathematics", National Council of Teachers of Mathematics, October 1987.

educational organizations. The best teachers in the nation can be used to reach an extremely large complement of students, while all teachers will have access to advanced learning materials for improved individual student attention.

One of the primary uses of the system will be teacher training. Teachers will have easy access to training in effective classroom computer usage and to a vast repertoire of science, mathematics and other important courseware. The possible educational uses and benefits from this system are far too numerous to attempt to itemize herein, but a partial list is presented in Appendix A. A list of some of the organizations and people associated with this effort is included as Appendix B. A few scenarios, illustrating how this system might be used, are included in Appendix C.

Conclusion:

For the first time in history, all of the required technology for implementing such a capable system is available. A timely opportunity such as this may come only once in the development of civilization. Even as we write, other countries (Japan, United Kingdom, Germany, France, Sweden, and Luxembourg) that recognize the opportunities are moving forward with DBS TV services, HDTV, and educational broadcasting, to implement at least some portions of what we have described.

Establishment of a digital DBS TV, HDTV, and educational broadcasting system could put America again in the forefront of technology and provide the means to rapidly bootstrap our science, mathematics, engineering and other educational systems back to an enviable leadership position.

However, the time to develop this opportunity is relatively short. The word for the day regarding America's technology and leadership is "use it or lose it." We can use our existing technology to invest in future education, thus preserving our technology base and national security, or we will lose it, abdicating our leadership and abandoning our industrial capacity to foreign competition, which is more educated, aggressive, and aware.

This program ties together past and present national policy initiatives in education and public benefits with national technological capability and a poised regulatory stance of willing implementers that is truly unique. Action must be initiated immediately. This promise and opportunity offers one of the highest reward-to-risk ratios ever seen.

Appendix A**Opportunities in Digital DBS and HDTV Systems****(YES Networks examples.)**

- Satellite educational programming to all public and private elementary and secondary schools and Universities in America;
- Undergraduate and Graduate education in businesses and homes;
- Inservice teacher training;
- Information data streams to all libraries in America;
- Educational programming to all child-care centers in America;
- Parent education in home or school;
- Specialized programs for disadvantaged, gifted, talented youth;
- Adult literacy;
- Student remedial programs;
- Senior citizen learning opportunities;
- Transmission of informational and innovative materials to schools, PTAs, school boards, administrators, teachers;
- Specialized programs for vocational-technical schools;
- Lifelong education, including graduate studies through the University of America;
- Education and data transmission to support migrant students;
- Improved, widely-accessible USDA market data information exchange;
- Medical training programs to hospitals and clinics;
- Medical information interchange among medical facilities;
- Assist prison inmates rehabilitation programs;
- Emergency Broadcast System;
- Professional requalification as required by state laws.
- Professional training and informational services (legal, accounting, financial, medical, engineering, etc.).

Appendix B

Organizations Directly Involved

Foundation for Educational Advancement Today (FEAT or Foundation): A 501(c)3 public charity formed to hold transponder (2) broadcasting rights on-board ACC's DBS system, acquire and donate miniature digital receiving antennas for every public and private school and library in the U.S., and to assist the YES Networks in its programming activities in appropriate ways.

Advanced Communications Corporation (ACC): A Federal Communications Commission licensed DBS permittee with authority to construct, launch, and operate two high-powered 16 transponder satellites covering the U.S. ACC has contracted with the General Electric Company to construct these two satellites.

Advanced Communications Engineering, Inc. (ACE): An affiliate of ACC which is designing transmission and reception capabilities for digital TV, digital HDTV, and related educational initiatives among other services for broadcast through ACC's DBS system.

YES Networks, Inc. (YES): The operational and programming arm for the comprehensive educational and informational services.

Associated Individuals

Honorable Wilbur D. Mills: Chairman and Trustee, FEAT; Chairman Emeritus, ACC; former Chairman, United States House of Representatives Committee on Ways and Means.

Mr. Daniel H. Garner, Jr.: President and Board Member, ACC; Board Member, ACE; Trustee, YES; former broadcasting and investment banking executive.

Mr. James M. Beggs: Chairman, ACE; Senior Advisor, ACC; former NASA Administrator, Chairman, Spacehab, Inc.

Mr. Donald K. Dement: Senior Vice President and Board Member, ACC; Vice Chairman, ACE; Senior Advisor, YES; former Director, NASA Communications Programs.

Dr. G. Gordon Apple: President, ACE; Vice President, ACC; Senior Advisor, YES; former TRW Senior Engineer and Bell Labs Engineer; Mgr. of digital HDTV project for CBS (1982-1983).

Mr. Wayne Wells: Treasurer and Trustee, FEAT; Senior Financial Advisor, ACC; former Treasurer and Board Member, General Dynamics Company.

Mr. Jackson T. Stephens, Jr.: Founding Board Member and Senior Financial Advisor, ACC; Senior Advisor, YES; CEO, Stephens Enterprises and related activities.

Professional Services

Legal: Mr. Richard S. Rodin, Esq., Hogan and Hartson, Washington, D.C.

Financial: Mr. Jerry Walton, Managing Partner, KMG Peat Marwick, Little Rock, Arkansas.

Attachment C**Scenario #1:**

Imagine, for the moment, a small-town mid-western school which previously had limited instructional capabilities in math and science. The students come into class, hand the instructor their homework assignments and sit down at their desks.

During the first few minutes, the instructor ask if there were particular difficulties with the homework. In response to each question, the instructor either directly answers the question, or enters it on a computer keyboard. The computer responds either with a direct answer or with information (received at the beginning of the class via the YES Networks) with which the instructor can formulate an answer. Alternatively, the computer indicates that a video response is available. Selecting the latter, the classroom HDTV video screens come alive with a verbal and pictorial explanation. Other questions are handled similarly.

The class then watches a half-hour lecture (on their HDTV monitors) which was prepared by one of the foremost educators in the nation on that particular subject. During this time, the instructor uses the computer to electronically grade part of the homework and then personally grades those portions that require written responses.

After the lecture, an additional period of questions and answers is handled by the instructor, again with the aid of the computer. The graded homework is returned along with reading material and tomorrow's homework assignment. The latter were printed automatically during the lecture. Additionally, two students are handed study hall assignments on disks which contain additional remedial programmed learning aids which have been automatically custom-prepared for them based on the homework scores. Another disk is loaned to an exceptionally bright student who wishes to pursue the subject in more depth.

At the end of class, the instructor picks up a printout (or a disk) containing the plan for the next week's classes, teacher preparatory material, and a sample exam which can be customized if desired.

Scenario #2:

A blue-collar worker comes home from a frustrating day at work. It has been difficult, but he has managed somehow to get by all these years without being able to read. He realizes that he is at a dead-end for job advancement but is too embarrassed to enroll in a local adult reading class. He turns on the television to view the listings of tonight's programs on DBS (his satellite receiver with a 2' antenna--

now as common as VCRs). He watches the videolog which presents a sequence of previews and short verbal descriptions of each of tonight's programs, plus selected previews for the next few days. He notices that the **YES Networks** has a beginning class starting tomorrow night on adult reading.

On the following nights he comes home, turns on the TV, and selects the class. The class consists of still-frame images, occasional full-motion windows, text, animation, and the instructor's voice. The instructor gradually leads the new student through the basics of reading. Interspersed in the lecture are multiple choice questions, such as identifying the spoken word or sentence from the displayed written choices. He uses his TV remote control to respond. A visible or audible TV response tells him whether his choice is correct or not. At the end of the program, his percentage of first-time-correct selections is displayed, verbalized, and compared with his previous scores. He is now on the way toward becoming literate, enriching his life, and being a more productive member of society and industry.

Scenario #3:

A college student returns home to her children after working half-day. Her husband is also a student and works the other half of the day. She has already finished her Bachelor's degree (mostly through **YES Networks** classes) and is now in medical school. Through the **YES Networks** and her home computer she is able to complete most of her classes without having to leave her young children with a baby-sitter.

She is presently taking a course in communicable diseases. This afternoon she especially wants to view a seminar on the latest research results on AIDS treatments. While she is watching the seminar, her computer disk is being down-loaded with a research paper written by the seminar speaker and containing the test results and statistical analysis being discussed during the seminar broadcast.

Later, for general interest, she audits a class on "Music Appreciation." Today's lecture on "the use of vocals within the symphonic form" is interspersed with excerpts from Mahler's 4th and Beethoven's 9th. The sound quality is the same as from her compact disk player.

Scenario #4:

A teacher who is unfamiliar with computers decides to take a training course offered through the **YES Networks** on basic computer operation. She turns the power switch on. After a little bit, a screen appears which contains a button for the **YES Networks**. She moves the mouse until the arrow is within the button. She clicks and a screen appears with a list of present or shortly available courses. After she makes a choice, the computer takes over and a voice says that the course will begin

in 3 minutes. The broadcast instructor begins and the computer acts almost the same as if it were a TV set. The only difference is that occasionally the instructor asks her to do some specific action and observe the results. Toward the end of the lesson, the course instructor asks her to insert a blank floppy disk to store reference materials, a written homework assignment (which is also output to the printer), and a programmed learning assignment which she can use on her own to become more familiar with the computer.

After a few lessons she decides that the computer is really not all that intimidating and she decides to try a course in improving her math teaching skills. She finds the course to be quite interesting and useful. Besides listening to the lecturer and watching the screen, the interspersed computer-interactive exercises keep her directly involved at a comfortable (but challenging) level. Besides helping her with her own level of expertise, additional materials, programs, and programmed learning are downloaded to a removable disk so that she can use them directly in her own classroom. Part of the broadcast course was devoted to showing her how to use these materials effectively in her own classroom.

Scenario #5:

Gerry is one of three students in his small high school that are taking a course in calculus. Until this year, there would have been no way that this school district could offer so advanced a course. In fact, this high school was not even going to be able to offer anything beyond first year algebra this year because the school's only math instructor took a much higher paying job (outside of teaching) in the next county and no replacement had been found. The required and advanced courses are now being offered by television through the YES Networks using an inexpensive satellite receiver with a 2' dish antenna which was quickly installed inside the building by pointing it through a skylight.

The course instructor is located in the state's capitol city, 200 miles away. Several schools in the state simultaneously receive the same course broadcast. Telephone links are provided for questions and interaction with the instructor.

On this particular day Gerry is home with a cold. He doesn't want to miss his calculus class because the college board exams are coming up shortly and he wants to do well in order to insure getting into a good engineering school. His parents recently bought a new HDTV set which included a built-in DBS receiver. For an additional \$200, they had also brought home a 2' DBS antenna assembly and mounting brackets which had allowed them to install and align it in about 20 min. Today, Gerry tunes his HDTV DBS receiver to the YES Networks broadcast of his calculus class. He watches the lecture and writes down the homework assignment for tomorrow. When he later returns to the class at the school, he is not behind the other students as otherwise might have been.

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March 24, 1989

Senator George Mitchell
 Majority Leader
 United States Senate
 Washington, D.C. 20510

Congressman Jim Wright
 Speaker of the House
 U.S. House of Representatives
 Washington, D.C. 20515

Re: HDTV - DARPA Proposal for Bid

Dear Senator Mitchell and Speaker Wright,

I am writing in regard to the recent announcements as reported in the media that the Department of Defense, in particular the Defense Research Projects Agency ("DARPA"), has offered \$30 million in grants for the development of technology relating to high-density television ("HDTV"). According to the reports, HDTV is "expected to be a \$50 billion industry by 2000." Moreover, it is also asserted that the United States could lose, annually, 750,000 jobs and suffer an additional \$225 billion trade deficit by 2010 if it lags behind any other country on HDTV. (New York Times, March 3, 1989, Business Day, p. D1; Report of Economic Policy Institute, as reported by the San Francisco Chronicle, March 9, 1989, pgs. C-1 and C-7.)

Further, according to these reports, the DARPA has received 87 applications, two of which were made by Sony Corporation of America, ("SONAM"), the American subsidiary of Sony Corporation of Japan, and the Philips Company of Holland.

Although DARPA's grants were "intended to assist United States manufacturers," bid applications were accepted from "foreign owned companies," SONAM and Philips, because the United States requires bids be decided by "fair and open competition."

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Senator George Mitchell
Congressman Jim Wright
March 24, 1989
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The purpose of this letter is to advise you that, in my opinion, the bids by SONAM and Philips are not and could not be the result of "fair and open competition," and should, therefore, be excluded and eliminated from consideration by DARPA.

The bases of my statement are as follows:

(1) SONAM, by the admission of Akio Morita, Chairman of SONAM's parent, Sony Corporation of Japan, already has developed a "working system" of HDTV with other Japanese companies. Therefore, it seems plain that SONAM seeks the full \$30 million grant for the sole purpose of preventing any American from winning the bid and "compete with us"; (A. Morita, March 7, 1989, NY, NY)

(2) SONAM, curiously the only Japanese company to bid, must be the "designated hitter" for the Japanese cartel, which has already invested \$500 million in HDTV and must prevent any entry by any American, except in conjunction with or on the terms dictated by the cartel; and

(3) Philips, the other foreign owned company to bid, is the co-chair with Sony of the Japanese-European consumer electronic products cartel, which has been meeting since at least 1982, for the purpose of coordinating, among other things, standards, terms and conditions for the world-wide manufacture, distribution and sale of HDTV.

It is difficult, if not impossible, to believe

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that either Sony or Philips 1/ need, or care, about the \$30 million grant, except to keep it away from the Americans and gain entry into the American military projects and HDTV in the United States.

When Sony and Philips are eliminated, as they certainly should and must be for soiling our bid process by infecting it with cartel action - hardly "fair and open competition" - DARPA must consider the Americans. In that respect, there are a number of companies who have bid who still believe in the American free enterprise system. Most of these companies are small companies who need the wherewithal for their research projects. Contrasted with these small companies, who have been the real source of new ideas and innovation in electronics, are large American companies who have abandoned the free enterprise system by combining their resources and making a bid as a so-called, "joint venture." These include such companies as the AT&T-Zenith combine and the combinations and consortia formed by Sematech and other American companies. In my opinion, AT&T, Zenith and the others who have formed consortia, should be ashamed of themselves. These companies were founded upon and achieved their great success from the free enterprise system of the United States. Whether their present intentions to form combines emanated from fear or greed is irrelevant to the fact that they have combined and know that by so combining they are denigrating the economic system which has so marvelously sustained our country for the last two centuries.

1/ One hopes that the Pentagon questions why only SONAM has bid rather than Sony of Japan; or why other Japanese companies such as, Matsushita, JVC, Sharp, Sanyo, NEC, Hitachi, Toshiba, Mitsubishi, and others, with hundreds of millions of dollars already invested in HDTV, have not applied; or why no other European company, including, Seimens, Grundig, Thomson, Thorne, and others, who also have major investments in HDTV, have not bid.

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The development of HDTV will be essential for the United States to maintain its technological leadership (which presently is in dire need of some stimulus). The small, independent companies who have submitted bids should be given the most consideration. The reason for this is, I respectfully submit, simple. These small companies still believe in competition and still believe in the free enterprise system, the most unique economic system in the world. These companies should be rewarded, not punished, for their belief in our free and open system of competition.

I am presently representing the U.S. patent holder of the dual-deck VCR, Go-Video, Inc., of Arizona, in an antitrust case against the Japanese cartel. I, therefore, find it mystifying that small American companies like Go-Video must file suit to be able to have the opportunity to do business in the United States and Japan, and then see the Japanese cartel welcomed as a bidder in this country. It would be different, of course, if the Japanese acted independently. But, they don't.

I respectfully submit that DARPA be advised of these considerations and, at the very minimum, require both Sony of America and Philips of Holland to state unequivocally that they do not act on behalf of any other Japanese or European companies and, further, that they do not act in conjunction with each other as a Japanese and European cartel. If these companies are unwilling or unable to categorically deny any such representation, then, I respectfully submit, they should and must be stricken from the bid proposal.

Very truly yours

Joseph M. Alioto
JOSEPH M. ALIOTO

JMA/hp
Mitchella

cc: United States Senators
United States Representatives
Hon. Carla Hills, U.S. Trade Representative
Hon. Robert Mosbacher, Secretary of Commerce

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Senator George Mitchell
Congressman Jim Wright
March 24, 1989
Page 5

cc: (Continued from Previous Page)
Charles M. Rule, U.S. Dept. of Justice
Antitrust Chief, Europe
Antitrust Chief, Japan
Chairmen of the Board
American Telephone & Telegraph
Zenith Corporation
Sony Corporation
Philips Corporation

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